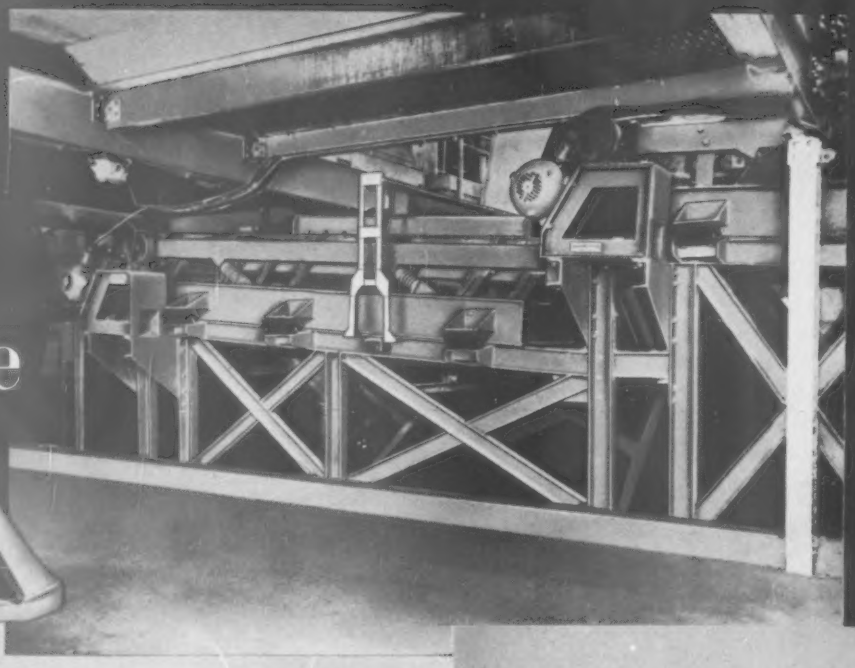
Vibration and maintenance



Cushioning the shocks stops metal fatigue

Maintenance on screens at the Lynemouth (Northumberland) colliery has been greatly reduced by the application of Metalastik anti-vibration mountings.

The Lynemouth washery is one of the largest single units in the United Kingdom and large amounts of coal are handled per hour on screens operating several hours a day. In February 1956, the No. 1 Primary Spray Screen and the No. 1 Primary Drainage Screen were placed on Metalastik Cushyfoot mountings.

Vibration and noise were immediately reduced.

Cushyfoot mountings are of particular value for mounting screens as they permit the greatest movement in the direction most needed, i.e. along the length of the screen, relieving the screen frame and holding-down bolts from stress.

VIBRATION DAMPING

Metalastik vibration cushioning devices range from those for sensitive instruments and internal combustion engines right up to those meeting the heaviest shock loads of industry.

FLEXIBLE BEARINGS

Silent, unlubricated and resilient, the various forms of Metalastik bushes for permitting pivotal movement have been well-proved by the millions in successful use.

FLEXIBLE COUPLINGS

A wide range of Metalastik couplings covers practically every requirement, catering for every kind of misalignment and damping out torsional fluctuations and shocks—some also transmit axial thrust.

METALASTIK

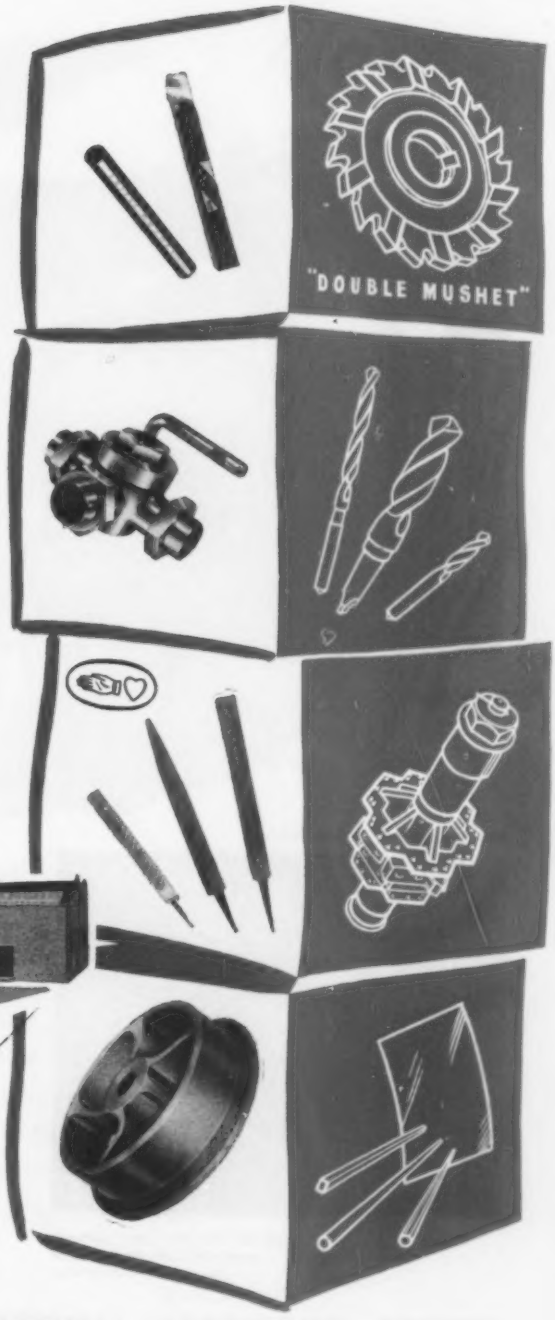
METALASTIK LTD., LEICESTER

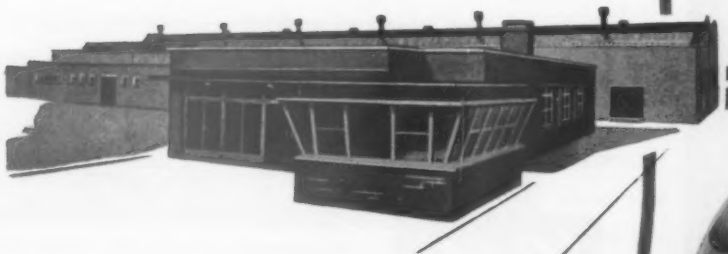
BUILD YOUR EFFICIENCY WITH

OSBORN PRODUCTS

Integrated experience from over a century of craftsmanship has made the name of *Osborn* world-famous as a hallmark of quality in the manufacture of fine steels and steel products.

Products in alloy, stainless and tool steels are manufactured throughout within the same organisation, and include castings by general foundry and precision methods, forgings and engineers' cutting tools.





STEELMAKERS · STEELFOUNDERS · ENGINEERS' TOOLMAKERS

SAMUEL OSBORN & CO., LIMITED

CLYDE STEEL WORKS, SHEFFIELD

Smooth

FSC Coupling

FSP Drive

CONTROLLED ACCELERATION TO FULL POWER

and every drive guaranteed!

BRITISH & WORLD PATENTS PENDING

Type FSC Hydraulic Coupling between motor and Crofts Worm Gear on flour milling machine drive.

CROFTS "FREE-SPACE" HYDRAULIC COUPLINGS & DRIVES

- Smooth controlled acceleration as well as protection of both motors and machines from damage due to stalling and overload.
- Motors and couplings may be selected for normal running horsepower, ignoring starting loads.
- Reduced initial cost of motors and starting gear.
- Simple installation and minimum maintenance.
- Units up to 100 h.p. at 1,450 r.p.m. are available from stock. Larger Units up to 700 h.p. can be supplied at short notice.

POST THIS COUPON TODAY!

Crofts
REGD TRADE MARK

☐ "FREE-SPACE" HYDRAULIC COUPLINGS AND DRIVES *Pub. 5951*

Literature also available on:

☐ Disc Type *Pub. 5748*
☐ "Perfect" *Pub. 5747*
☐ "Multiflex" *Pub. 5732*
☐ "ND" Crown Pin *Pub. 5730*
☐ "NTS" Internal Gear *Pub. 5736/AB*
☐ "MB" Internal Gear *Pub. 258*
☐ "Croft-Ring" Flexible Couplings *Pub. 5916*

PLEASE INDICATE ITEMS REQUIRED

Name & Address .....

.....

..... MW

CROFTS (ENGINEERS) LIMITED

POWER TRANSMISSION ENGINEERS

THORNBURY BRADFORD 3 YORKSHIRE Phone: 65251 (20 lines)

'Grams: "Crofters Bradford Telex" Telex 51186

REPRESENTATION THROUGHOUT THE WORLD

for pulley

use

15% more H.P. with Angus Maxgrip

The introduction of Maxgrip Belting has added a further success to a growing list of Industrial Rubber Products of outstanding quality, amongst which are Transmission and Conveyor Beltings, Suction and Delivery Hose, Rubber Sheet and Mouldings.

A9/59

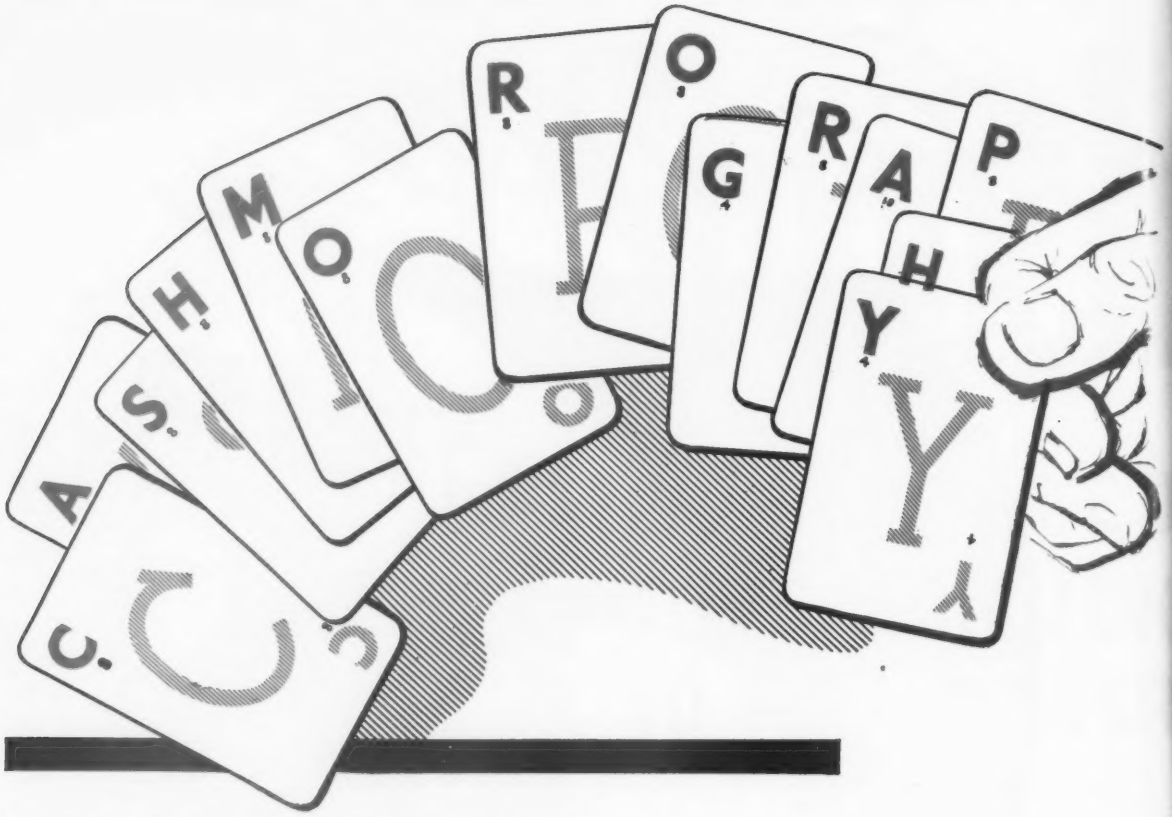
Maxgrip belting cuts out pulley slip because its driving ply, even when worn, has a consistently high coefficient of friction. This pulley-gripping ply is made from cotton yarns and rubber latex spun together in a vacuum—*each individual fibre of cotton is fully coated with natural rubber.* This enables Maxgrip belting to be run at a lower tension, greatly reducing pulley shaft wear and fastener strain. Maxgrip will always transmit 15% more power at 180° arc of contact than its equivalent in conventional belting.

Made only by

GEORGE ANGUS & Co LTD

ANGUS HOUSE, NEWCASTLE UPON TYNE, 1

EXPORT DIVISION: 300 GRAYS INN ROAD, LONDON, W.C.1.



Lexicography is the art of building a dictionary—but CASHMOROGRAPHY is simply another word for "STEEL FROM STOCK." It's a big word to describe a comprehensive service—large stocks; quick deliveries; rapid contact through TELEX—and a service to end the need for stocks on your own premises.

CASHMORE'S stocks are your stocks.

Try CASHMOROGRAPHY—it's a winning word!!!

CASHMORES

Accredited Sheet Stockholders of the Steel Company of Wales Limited

JOHN CASHMORE LIMITED

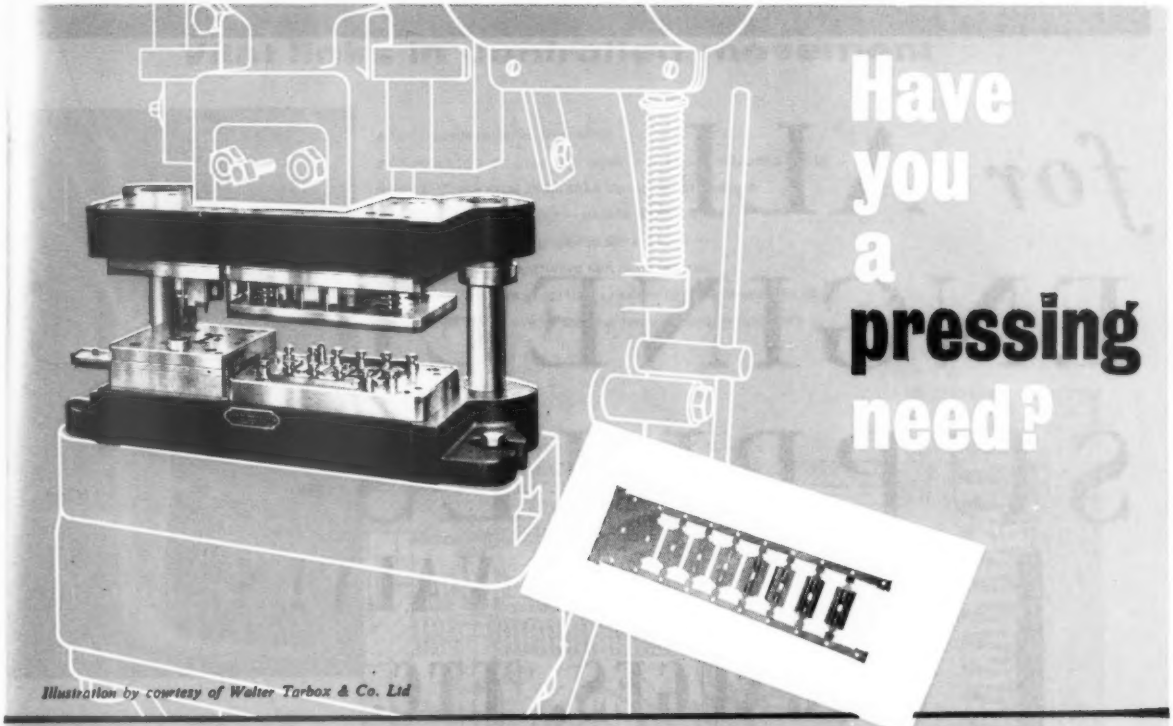
GREAT BRIDGE
TIPTON · STAFFS
Tel: TIPton 2181/7 Telex: 33169

NEWPORT
MON.
Tel: 66941/6 Telex: 49248

LONDON OFFICE: 75 Victoria Street, London, S.W.1
Telephone: ABBey 4556/7/8

FOR STEEL FROM STOCK

- SHEETS
- ANGLES
- BARS
- PLATES
- JOISTS
- STRIP
- BRIGHT DRAWN BARS
- STAINLESS BARS AND SHEETS



Have you a pressing need?

Illustration by courtesy of Walter Tarbox & Co. Ltd

KE

KE 672 is an excellent general purpose oil hardening tool steel. When worked under normal conditions it is trouble free and ideal for a wide variety of blanking, pressing and piercing operations.

KE 637 is a first class low temperature oil hardening tool steel with deep hardening properties. It is an excellent steel for gauges and tools of intricate shape where final grinding after hardening is not permissible.

KE 595 is an oil hardening tool steel with deep hardening properties and extra wear resistance. Due to its hardenability in comparatively large sections it is suitable for presswork involving greater tool mass.

KE 970 is a 2% Carbon 14% Chrome High Duty Tool Steel, used for a variety of exacting blanking and pressing operations. For increased toughness at a slight loss in hardness we supply KE961 1½% Carbon 12% Chrome Steel.

Stocks held in Sheffield, the Midlands and London

This booklet, giving greater detail, is available free on request.

KAYSER ELLISON & CO. LTD

CARLISLE STEEL WORKS · SHEFFIELD

TEL. SHEFFIELD 22124 **ESTABLISHED 1825**

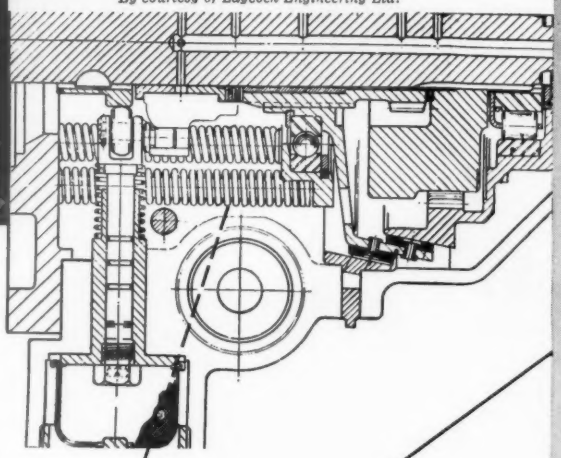
London Stock Warehouse:
4 Pembridge Mews, Notting Hill Gate, W.11 Tel. BAYswater 9131/2

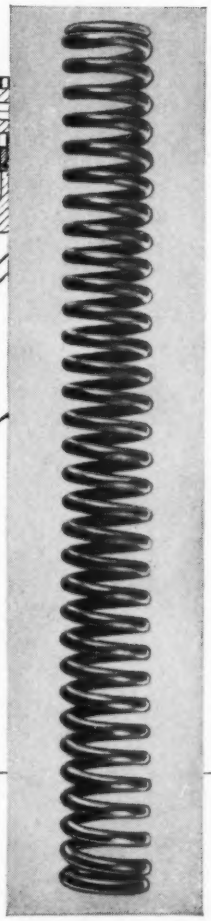
Midland Stock Warehouse:
Station Road, Coleshill, Birmingham. Tel. Coleshill 2041/2

Vital links in controlled movement

A body needs muscles to control movement in very much the same way as a mechanism needs springs. These vital links take the stress and strain of every day rigorous use — nature provides the muscles SALTER provides the springs. Two centuries of experience and development in the manufacture of springs of every type have enabled us to keep ahead of the ever-changing requirements of industry.

By courtesy of Laycock Engineering Ltd.





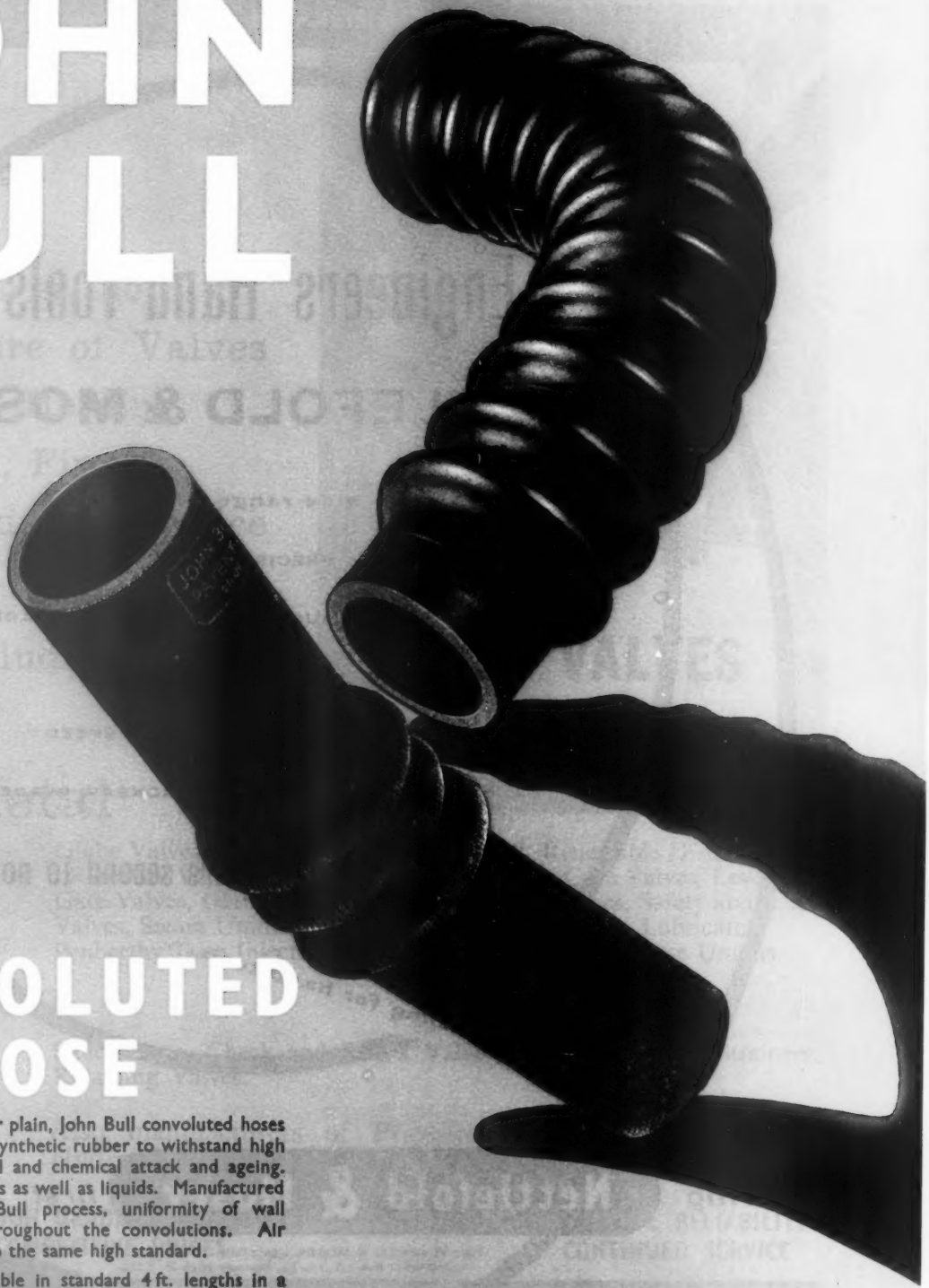
For springs with the highest reputation and top performance specify SALTER all-action springs.

The applications for SALTER springs are wide and varied — from heavy machinery to finely balanced instruments.

SALTER ESTABLISHED 1760

GEO. SALTER & CO. LTD.
WEST BROMWICH
ENGLAND

JOHN BULL



CONVOLUTED HOSE

Stockinette re-inforced or plain, John Bull convoluted hoses are made in natural or synthetic rubber to withstand high and low temperatures, oil and chemical attack and ageing. They are suitable for gases as well as liquids. Manufactured by the patented John Bull process, uniformity of wall thickness is retained throughout the convolutions. Air cleaner hoses are made to the same high standard.

All rubber hose is available in standard 4 ft. lengths in a range of diameters. Specially fashioned hoses can be manufactured to your requirements.

In addition to Convoluted Hose, John Bull products include Boots and Gaiters, Shaped Hoses and Rubber Mouldings.

JOHN BULL RUBBER CO. LTD. (Industrial Sales Division) LEICESTER

TELEPHONE: 36531

SPEED REDUCERS . . .

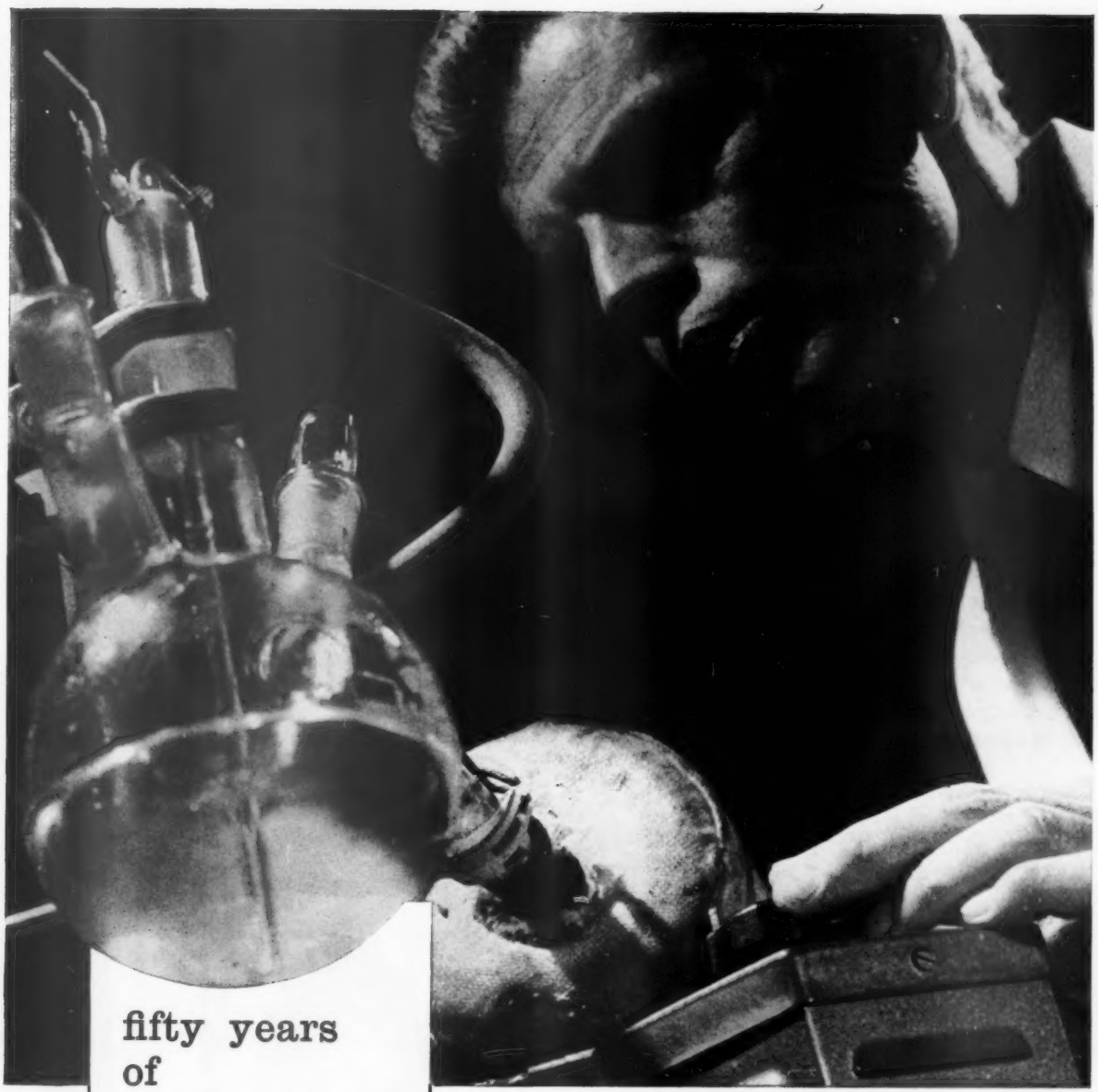
. . . trouble free whichever way you look at them

For efficient, trouble-free speed reduction you can rely on a Radicon. These compact, efficient reduction units can be mounted in almost any position to do almost any kind of job. And once mounted, they run with the minimum of attention. You have a choice of 40 alternative mounting positions and of 64 ratios ranging from 5 : 1 to 3600 : 1. But to learn full details, you'll need our Catalogues Nos. E 387-96 and E 387-108. We'll be glad to send you copies.

DAVID BROWN

THE DAVID BROWN CORPORATION
(SALES) LIMITED.

LONDON GEAR DIVISION, STONEBRIDGE PARK WORKS,
NORTH CIRCULAR RD., LONDON, N.W.10
TEL.: ELGAR 6824



fifty years of looking ahead

THIS year we can look back on fifty years of looking ahead. In 1910 the first two dispersions* of colloidal graphite to be manufactured in this country were introduced by the British unit of the Acheson Organisation. Still extensively used in industry, these products are now supplemented by dispersions of graphite, molybdenum disulphide, PTFE, boron, glass, silver, mica, vermiculite and other solids. Today Acheson dispersions have a thousand and one uses in every branch of industry and benefit boffins and boiler-makers, shipwrights and spacemen, time and motor men, organ makers and means testers, kingpins and needle makers. The Acheson range is many things to many people in most industries.

50 YEARS

Acheson Colloids

LIMITED

(a subsidiary of Acheson Industries (Europe) Limited)

P.O. BOX 12 · PRINCE ROCK · PLYMOUTH · DEVON

ACHESON

*"Oildag" colloidal graphite in oil and "Aquadag" colloidal graphite in water. "Oildag" and "Aquadag" are registered trade marks.

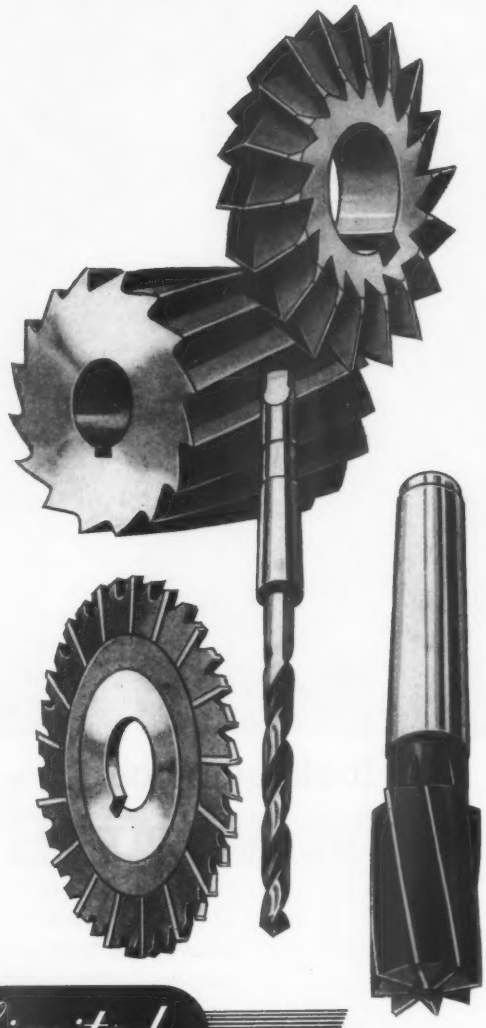
ALSO ACHESON COLLOIDS CO., PORT HURON MICHIGAN U.S.A. & ACHESON COLLOIDEN N.V. SCHEEMDA (GR) NETHERLANDS

Engineers'

CUTTING TOOLS

Twist drills, centre drills, core drills, reamers, end mills, milling cutters, slitting saws:

Large stocks available for immediate despatch. Send today for our fully illustrated catalogue (No. 30), containing all you need to know about the Richard Lloyd Service ; Useful Data ; Prices ; Separate section for twist drills, reamers and milling cutters with fullest information on the nomenclature, design and specification of each.

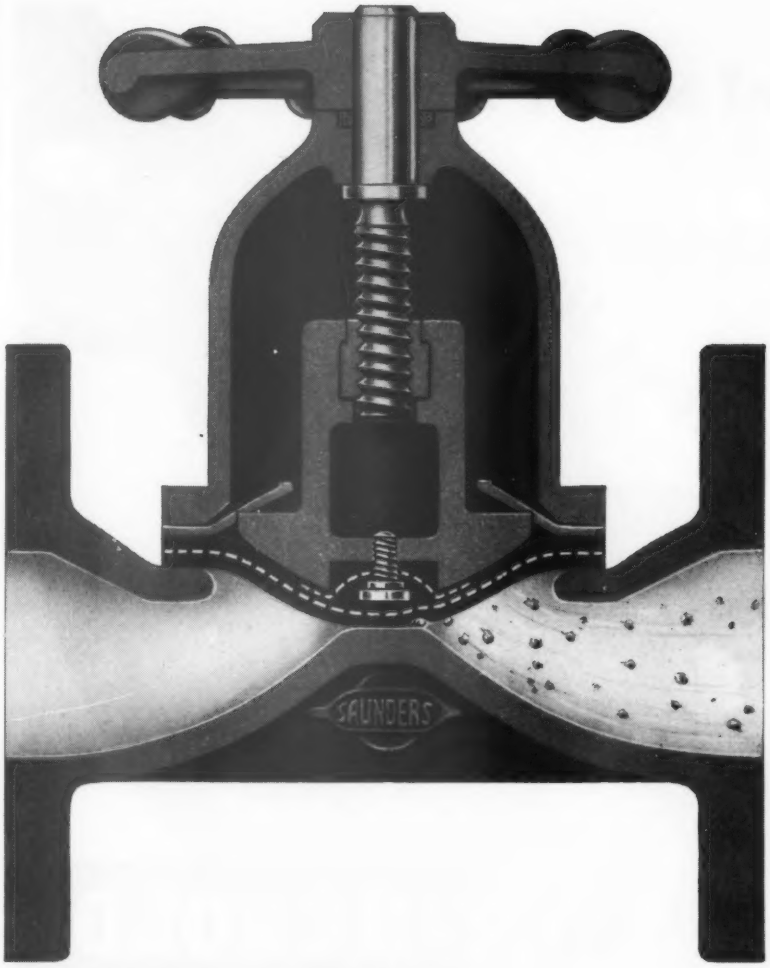


Richard Lloyd Limited

GALTON HOUSE, ELMFIELD AVENUE, TYBURN, BIRMINGHAM, 24

Telephone: ASHfield 1801 Telegrams: "Cogs, Birmingham" Telex No. 33366

NORTHERN AREA OFFICE: Britannia House, Wellington Street, Leeds, 1. Telephone: Leeds 21212.
LONDON AREA OFFICE: 240, Romford Rd, Forest Gate, London E. 7. Telephone: Maryland 7304-5



— so very useful when handling slips, slurries, sludges, pulps, powders, foodstuffs, ground glass and all abrasive fluids.

DIFFERENT - - to ensure perfect closure even with solids in suspension

SAUNDERS DIAPHRAGM VALVES

Grit or small solids in the fluid, if trapped on closure, just embed themselves in the flexible diaphragm and are freed when the valve is opened.

SAUNDERS VALVE COMPANY LIMITED
DIAPHRAGM VALVE DIVISION
CWMBRAN MONMOUTHSHIRE ENGLAND

for a good start ...

... and a perfect finish

fit RENOLD

HIGH-EFFICIENCY CHAIN DRIVES

RENOLD
CHAIN DRIVES

Give instant starting and smooth acceleration to full load without slip

Have a positive gearing action not depending on frictional contact

Simplify mechanical arrangements in large drives by obviating the need for outboard bearings

Do not cause chatter and vibration, thus ensuring perfect product finish

RENOLD *HIGH-EFFICIENCY* CHAIN DRIVES

can be supplied off-the-shelf up to 140 h.p., with a choice of 25 ratios and 64 shaft-ready pinions READY BORED AND KEYWAYED.

Standardised Design Drives are available up to 4,000 h.p.

RENOLD

RENOLD CHAINS LIMITED · MANCHESTER

Over a Ton of Aluminium Alloy spun to 10 ft. i/d x $1\frac{5}{8}$"

One of a number produced for pressure vessels to hold liquid air, this 10 ft. aluminium end was spun by Harveys on the Rotarpress. The 12 ft. flat discs needed for spinning these ends, which are believed to be the largest spun aluminium ends produced in this country, were formed by butt-welding two plates of aluminium alloy together.

The Rotarpress is one of the large-capacity units in Harveys Heavy Fabrication Department. It produces ends up to 15 ft. diameter and is adaptable over a wide range of knuckle radii and depths.

The contours of semi-ellipsoidal ends produced by the spinning process enable plate thickness to be reduced, and in most cases tool costs are eliminated. Enquiries are invited for ends only or for complete

FABRICATION OF PRESSURE VESSELS.

HARVEY

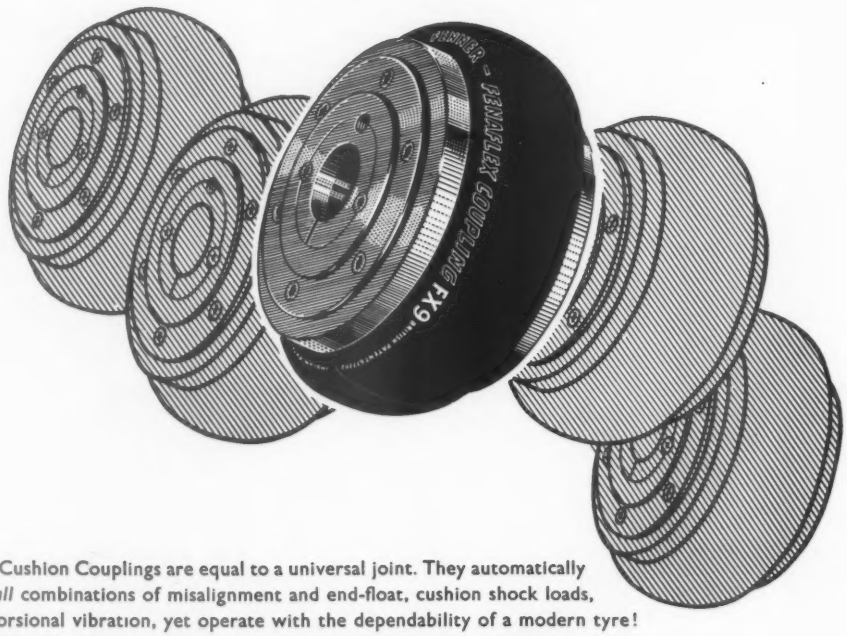
G. A. HARVEY & CO. (LONDON) LTD.

Woolwich Road, London, S.E.7. GREenwich 3232 (22 lines)

Other Harvey facilities: FABRICATIONS UP TO 120 TONS IN ONE PIECE · HEAVY MACHINING AND FITTING · HEAT TREATMENT AND RADIOGRAPHY · STEEL PLATE AND SHEET METALWORK · PERFORATED METALS · WOVEN WIRE · WIREWORK HH/7

F|E|N|A|F|L|E|X

CUSHION COUPLINGS



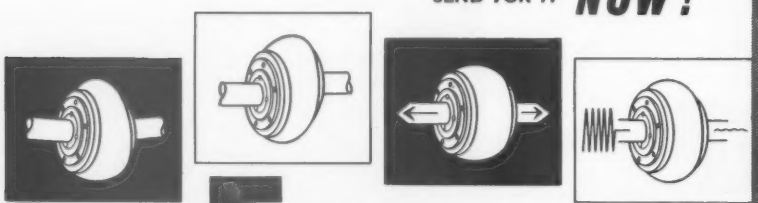
THE RUBBER TYRE COUPLINGS WITH THE FOUR-WAY FLEX

Fenaflex Cushion Couplings are equal to a universal joint. They automatically correct *all* combinations of misalignment and end-float, cushion shock loads, reduce torsional vibration, yet operate with the dependability of a modern tyre! The Fenaflex Coupling *is* a tyre with synthetic tension members bonded in rubber. Depending on the size of the coupling and the duration of shaft misplacement, it corrects angular misalignment up to 4°, parallel misalignment up to $^{1}/_{8}$ inch and end-float up to $^{5}/_{16}$ inch. There is no metal-to-metal contact, lubricating is unnecessary and there are no protruding parts.

This coupling occupies the minimum space on the shaft and Fenner standard Taper-Lock bushes make mounting quick and easy. As the flexible member is moulded with a transverse split, it can be replaced without moving the machine or the motor. This flexible coupling with time-saving TAPER-LOCK for fixing, is available in 9 sizes, the largest taking 20 h.p. per 100 r.p.m.

Leaflet 353/18 will give you full technical information.

SEND FOR IT **NOW!**



Fenner

J. H. FENNER & CO. LTD · MARFLEET · HULL

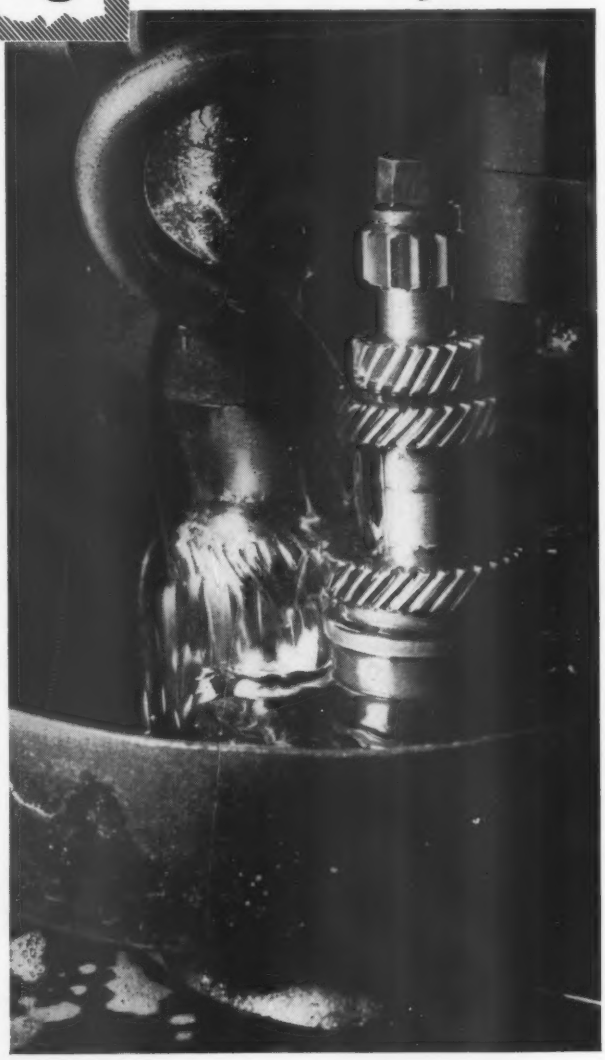
Fenaflex Couplings are obtainable from stock at all 19 Fenner branches and Fenner engineers will gladly demonstrate Fenaflex to you—telephone your nearest branch.

Belfast · Birmingham
Bradford · Bristol · Burnley
Cardiff · Glasgow · Hull · Leeds
Leicester · Liverpool · London
Luton · Manchester
Middlesbrough · Newcastle
Nottingham · Sheffield · Stoke

LARGEST MAKERS OF V-BELT DRIVES IN THE COMMONWEALTH

Does chip welding trouble you?

Many machining difficulties — poor finish, lack of accuracy, reduced tool life — derive from the welding of chips to the tool when cutting. But these are essentially symptoms. The real trouble is inadequate performance of the coolant. The cure may be a change to FLETCHER MILLER cutting fluids. They cool the chip, the tool and the workpiece thoroughly; they lubricate the tool and chip, creating an anti-weld effect between them. As a consequence, higher speeds or feeds are possible whilst maintaining accuracy and finish. The whole range of FLETCHER MILLER cutting fluids is described in our Publication SP. 173 "Cutting Fluids". We will be pleased to send you a copy if you write on your business letter heading.



specify

FLETCHER MILLER

cutting fluids

INTERNATIONAL MACHINE TOOL EXHIBITION 1960
Olympia · London June 25-July 8

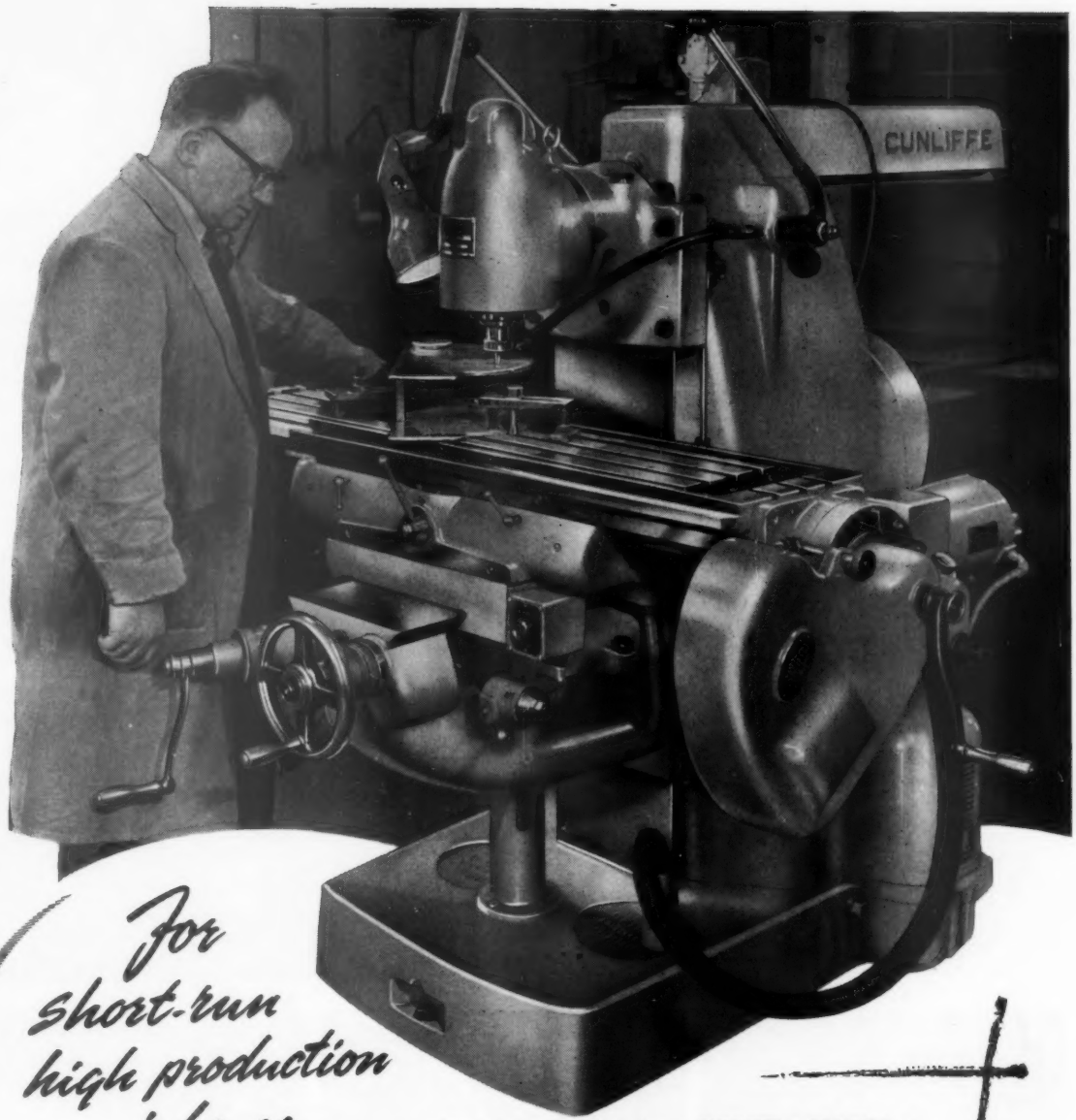
Visit our Stand
No. 618
EMPIRE HALL, 2nd FLOOR

SWIFTEX

This straight oil is supplied in two grades. Sulphurised to undertake heavy work under severe tooling conditions and non-sulphurised for high performance work on non-ferrous metals and special alloys. Either blend is very suitable for gear cutting.

FLETCHER MILLER LTD., ALMA MILLS, HYDE, CHESHIRE
Telephone: HYDE 3471 (5 LINES) · *Telegrams:* EMULSION HYDE
Also at LONDON, WEST BROMWICH, NEWCASTLE-ON-TYNE, CARDIFF, GLASGOW AND BELFAST

CFI21



For short-run high production jobs or --

. . . or for prototype work as shown, CUNLIFFE & CROOM horizontals, with their in-built features of precision and rigidity mean increased efficiency wherever they are installed. At the Imperial Tobacco Co., Ltd., Bristol, for instance, this machine, with vertical milling attachment, is fully employed in the Prototype Development Dept., on components for new machines. CUNLIFFE & CROOM milling machines, horizontal, universal and vertical, are available in a range of sizes to reduce costs on your own work. Complete catalogues available. *Write for your copies today.*

CUNLIFFE & CROOM

HORIZONTAL MILLERS

FULL PARTICULARS OF THESE MACHINES FROM

JAMES ARCHDALE & CO. LTD.

Registered Office: Ledsam Street, Birmingham, 16. *Tel: EDGBASTON 2276*

Works: Blackpole Works, Worcester. *Tel: Worcester 27081*

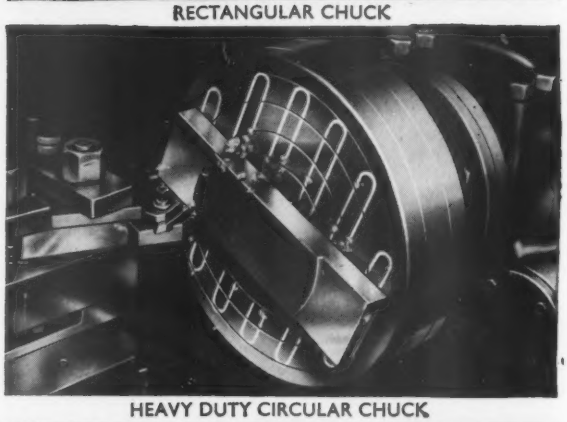
A member of the Staveley Coal & Iron Co. Ltd. Group

Sole Selling Agents: Alfred Herbert Ltd., Coventry *Tel: Coventry 89221*

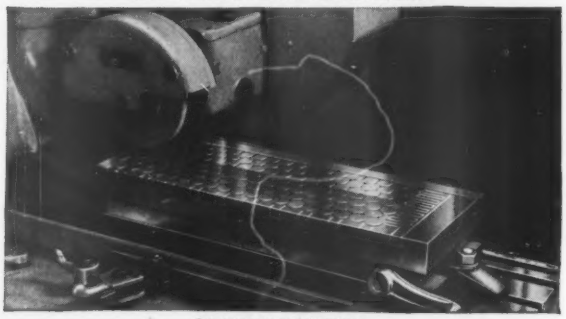
Eclipse

offers the most complete magnetic work holding service

RECTANGULAR CHUCK



HEAVY DUTY CIRCULAR CHUCK



FINE POLE CHUCK

MINOR CHUCK

MAGNETIC VEE BLOCK

SMALL TOOLMAKERS CHUCK
MOUNTED ON SWIVELLING BRACKET

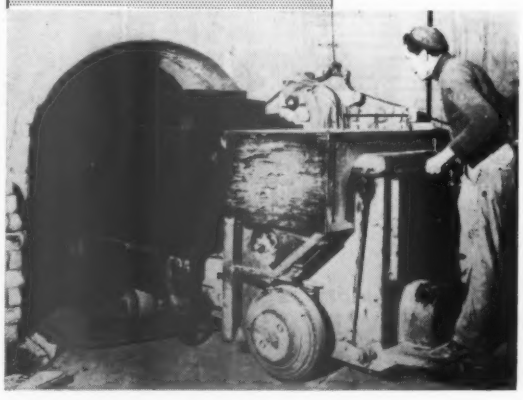
Ask for detailed literature

Made by James Neill & Co. (Sheffield) Ltd. and available through your usual 'Eclipse' dealer

PM 156

WESTINGHOUSE

BATTERY CHARGERS
for
Industrial Trucks
at the Marston Valley Brick Co., Ltd.



The transportation of bricks to and from the kilns at the Marston Valley Brick Co. Ltd., is performed by battery electric trucks. Westinghouse chargers maintain the heavy duty batteries in service under these arduous conditions.

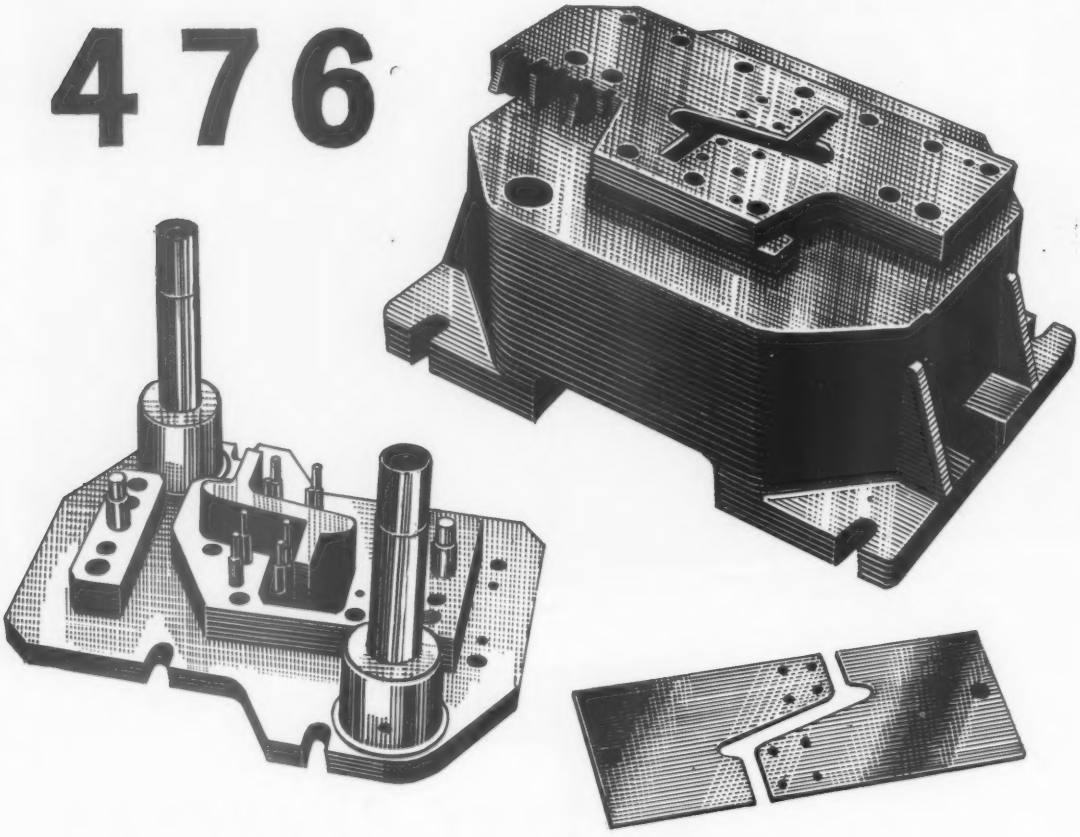
Full details of Westinghouse germanium or selenium chargers will be sent on request to Dept. M.W. 4.

WESTINGHOUSE BRAKE AND SIGNAL Co. Ltd.

82 York Way, Kings Cross, London, N.1. TERminus 6432

SANDERSON tool steels

476



'476' Heavy duty die steel of the high carbon, high chromium type, has outstanding wear-resistance but is tough and machinable. It is particularly recommended for tools operating under conditions of severe wear and abrasion and where maximum runs are required.

The above illustrations show a punch and die set produced from '476' steel by The Mining Engineering Co. Limited, Worcester.

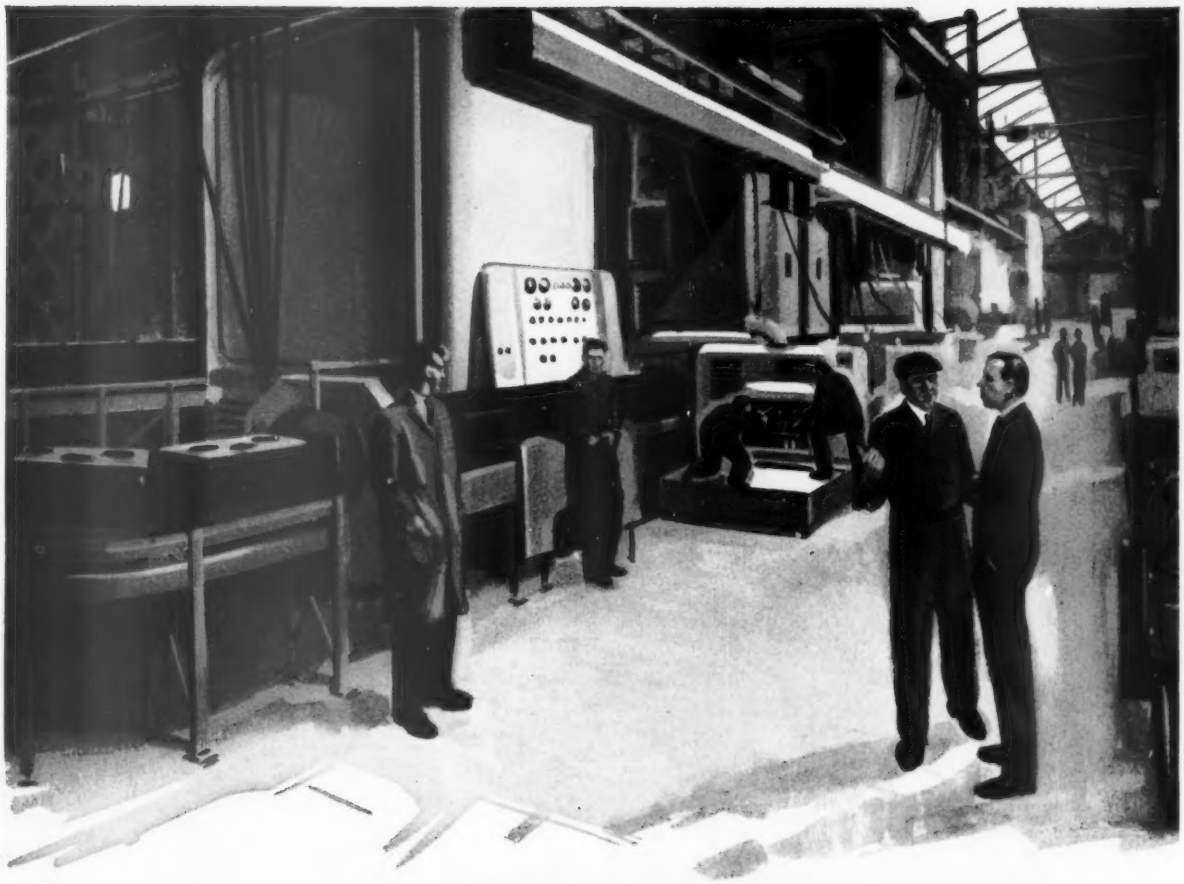
SANDERSON'S ESTABLISHED 1776

STEEL SAWS TOOLS

Please write for further details and literature.

SANDERSON BROTHERS AND NEWBOULD LIMITED

Attercliffe Steelworks, P.O. Box 6, Newhall Road, Sheffield 9



When hold-ups cost money . . .

. . . and ordinary lubricants have failed—Rocol Molybdenised Lubricants are the answer. Plating tough, wear resistant molybdenum disulphide—the most advanced lubricant known to engineering science—on to all bearing surfaces. Rocol Molybdenum Disulphide stays in action in conditions of high pressure, or extremes of temperature, up to 100,000 lbs. p.s.i. and 1000°F. On installations that are inaccessible and difficult, perhaps dangerous to get at, Rocol Molybdenised Lubricants substantially lengthen the period between essential maintenance operations.

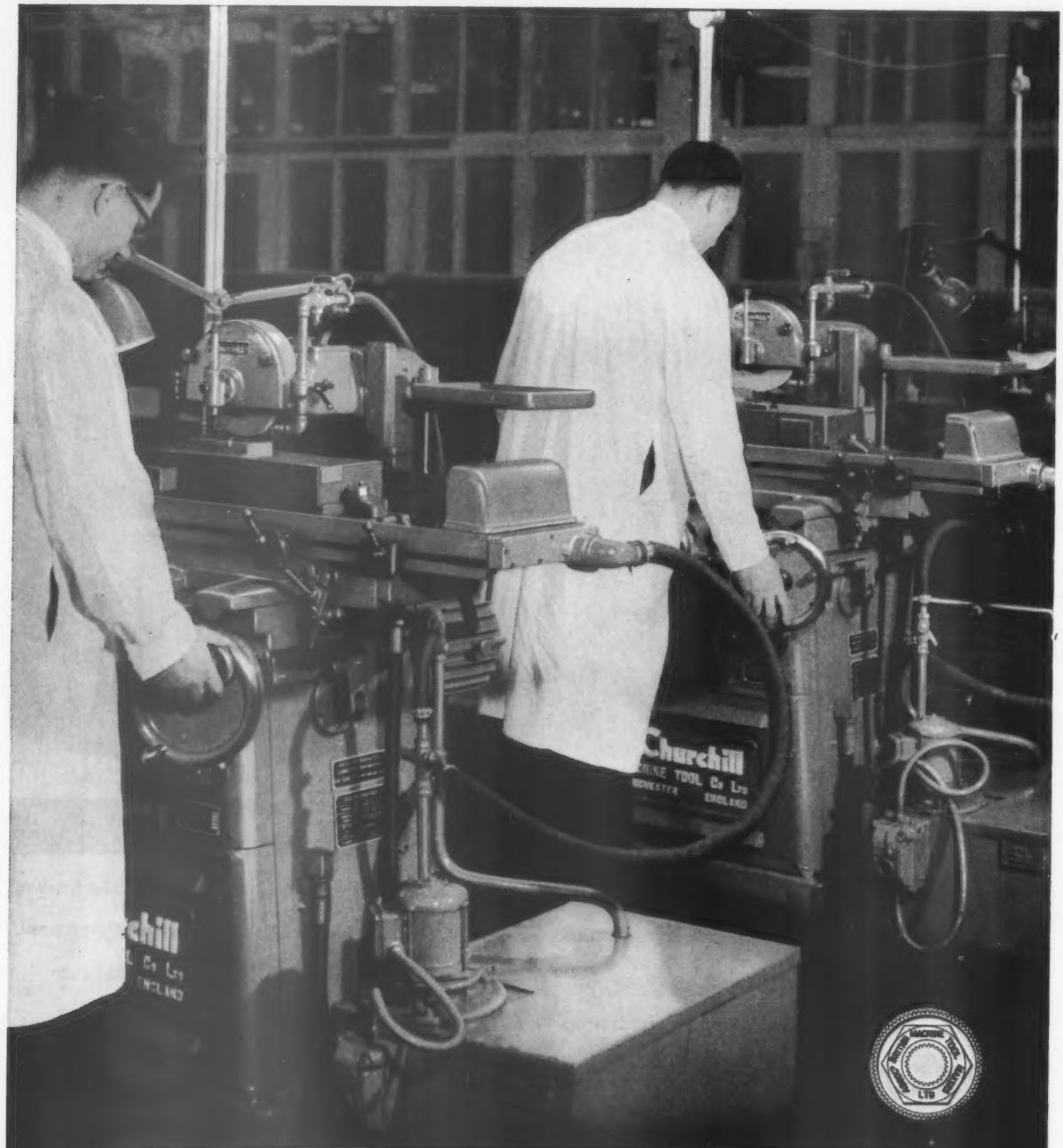
USE Rocol MOLYBDENISED LUBRICANTS

In various forms to suit every application, including yours.
Write today for detailed publications.

ROCOL LIMITED
General Buildings · Aldwych · London W.C.2 · Tel. HOLborn 1985
Rocol House · Swillington · Leeds · Tel. Garforth 2261

A Rocol PRODUCT

1083Xb



Grinding Components for Marine and Aeronautical Equipment to Fine Limits at Sperry Gyroscope Co. Ltd. on

Churchill

MODEL NB 18 x 6 IN.

HORIZONTAL SURFACE GRINDING MACHINES

THE CHURCHILL MACHINE TOOL
Broadheath, nr. Manchester. Co. Ltd.

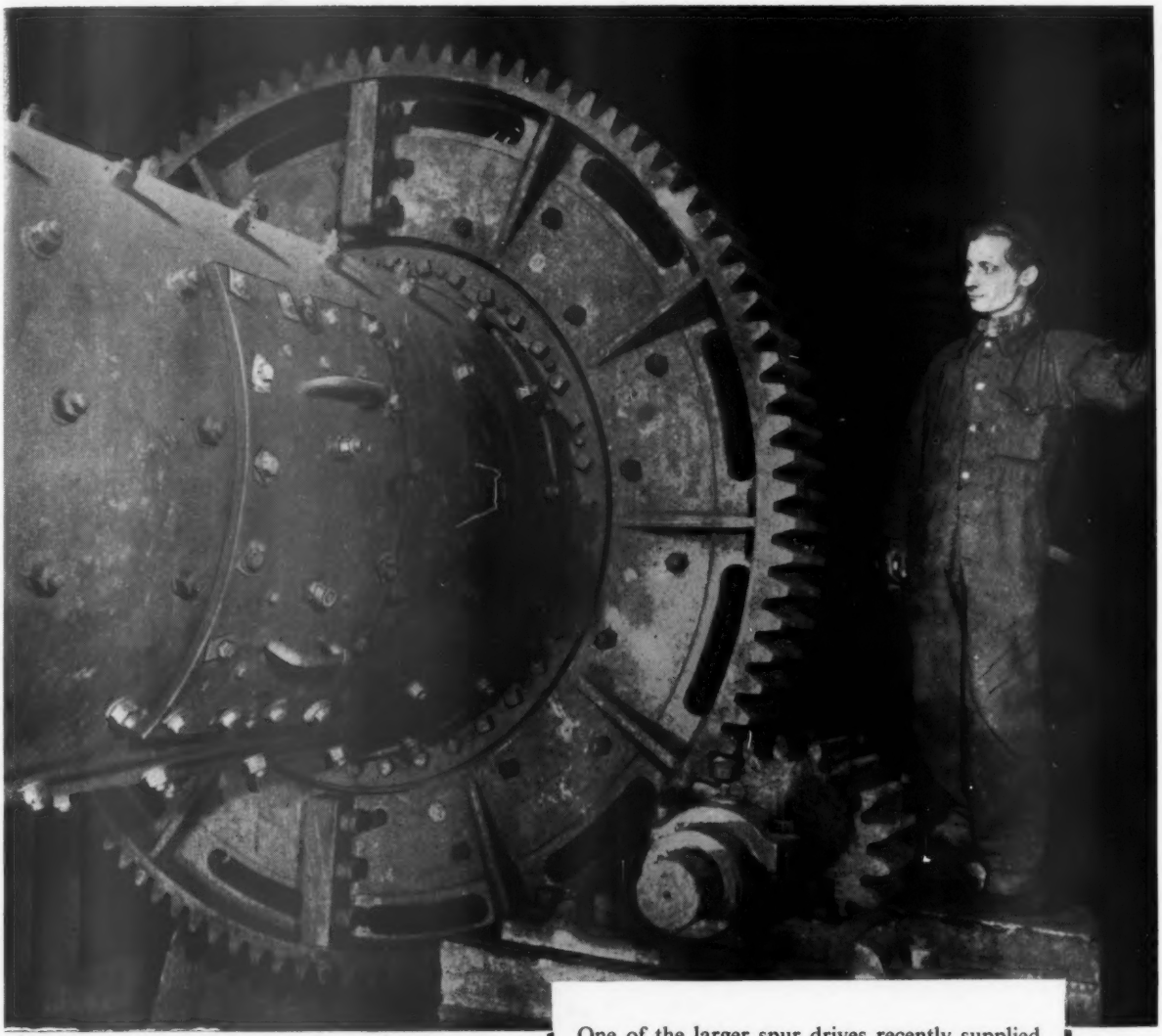
Export Sales Organisation

ASSOCIATED BRITISH MACHINE TOOL MAKERS LTD.
London Branches & Agents

Home Selling Agents

CHARLES CHURCHILL & CO. LTD.
Birmingham & Branches

C671-1C



Photograph by kind permission of:
Wm. Cummings & Co. Ltd., Chesterfield.

One of the larger spur drives recently supplied by us for a rotary crusher. Our long association with the heavy industries is one more reason for specifying: "Gears by Aurora". For all applications, large or small send us your enquiries—our long experience is at your service.

AURORA
GEARS

Established since 1880

Our technical representatives will be pleased to call and discuss your requirements.

AURORA GEARING CO.
(WILMOT NORTH) LTD.
EDMUND ROAD, SHEFFIELD
(A subsidiary of the Aurora Gear & Engineering Co. Ltd.)
Phone: Sheffield 24385-6-7

Efficiency over 98%

with AEI

STANDARD INDUSTRIAL GEARBOXES

Helical gear units are available in standard sizes from 10 to 4,000 h.p. for input speeds up to 3,000 r.p.m. The range of ratios is from 2:1 to 7:1 dependent on horse-power. Ball and roller bearings are fitted throughout the range; no external lubrication is required.

A further range of helical gear units gives ratios up to 30:1.

AEI industrial gears are manufactured on the finest precision hobbing machines, housed in separate temperature- and humidity-controlled cells.

For further information and technical data please telephone ***Rugby 2121 ext. 108***

ASSOCIATED ELECTRICAL INDUSTRIES LIMITED

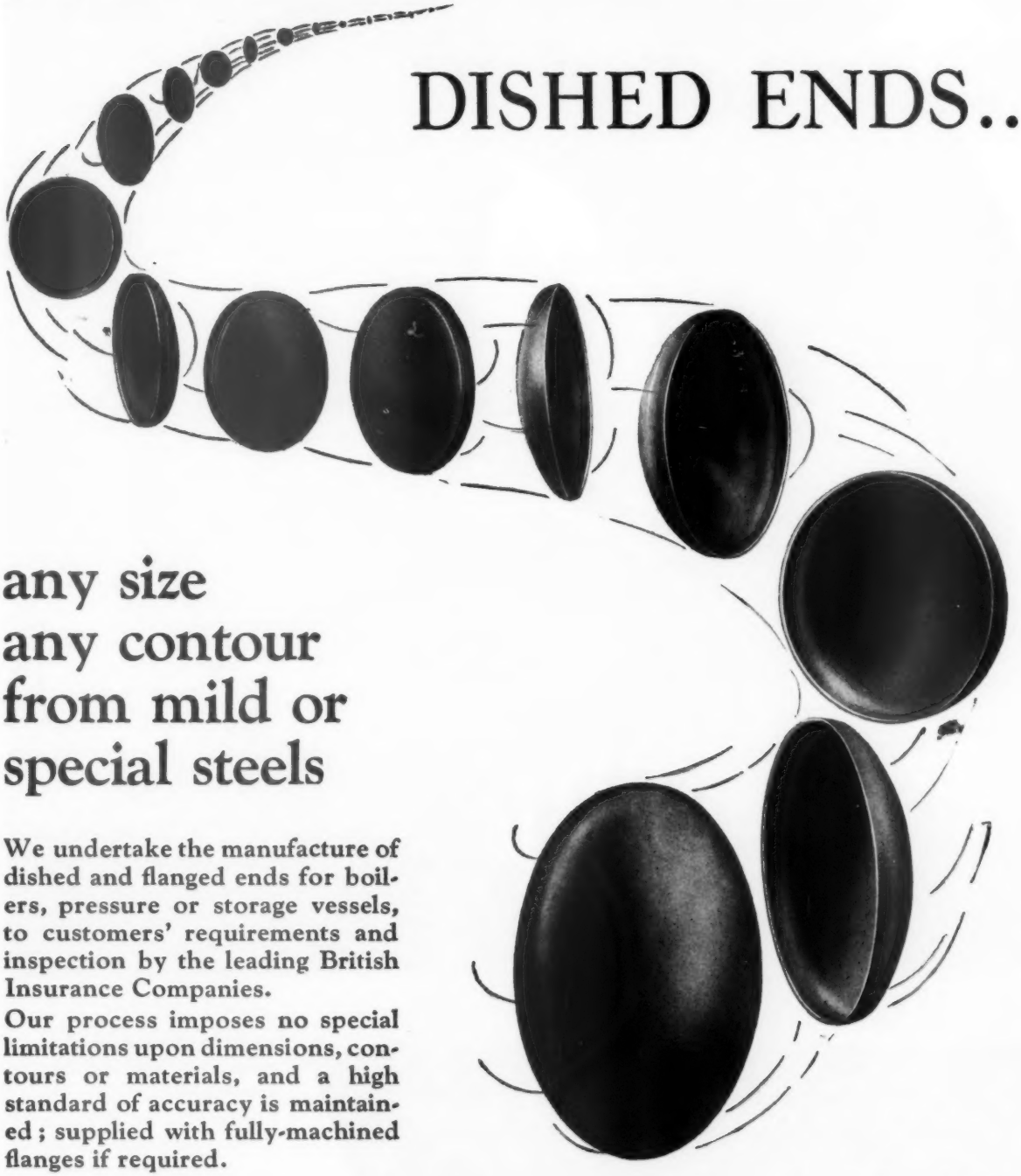
HEAVY PLANT DIVISION — **RUGBY & MANCHESTER, ENGLAND**

A.S.E.E. EXHIBITION—VISIT STAND No. L9

A5380

JOSEPH ADAMSON

DISHED ENDS..



any size
any contour
from mild or special steels

We undertake the manufacture of dished and flanged ends for boilers, pressure or storage vessels, to customers' requirements and inspection by the leading British Insurance Companies.

Our process imposes no special limitations upon dimensions, contours or materials, and a high standard of accuracy is maintained; supplied with fully-machined flanges if required.

JOSEPH ADAMSON & CO. LTD.
P. O. BOX 4 · HYDE · CHESHIRE

In association with
Adamson Alliance Co. Ltd., 165 Fenchurch St., London, E.C.3
The Horsehay Company Ltd., Wellington, Shropshire

THE ADAMSON GROUP

J.A.4.

For every class of Electrical Repair

The complete electrical repair service including rewinding to any insulation specification.

Branches at :— Bath, Birmingham, Cardiff, Chesterfield, Edinburgh, Glasgow, Hawick, London, Manchester, Newcastle-upon-Tyne, Swansea.

BRITISH ELECTRICAL REPAIRS LIMITED

EMPIRE HOUSE, CHARLOTTE STREET, MANCHESTER, 1.

Telephone: CENtral 1378 (3 lines) and CENtral 3641 (2 lines).

*dm*BER110

Mechanical World

AND ENGINEERING RECORD

Vol. 140 APRIL, 1960 Number 3489

Contents

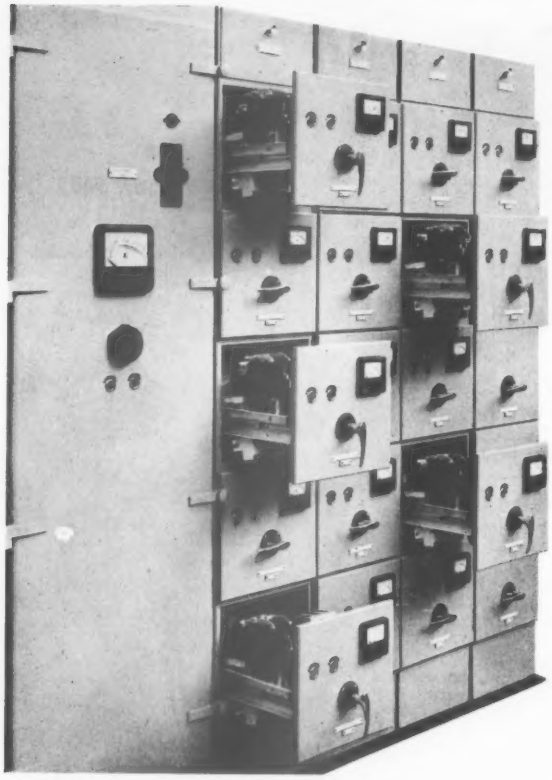
MECHANICAL WORLD AND ENGINEERING RECORD is published monthly in Manchester and London.
MANCHESTER: 31 King Street West, 3.
Telephone: BLAckfriars 7086.
Telegrams: Textile, Manchester.
LONDON: 158 Temple Chambers, Temple Avenue, EC4.
Telephone: FLEet Street, 8914.

Subscriptions. The annual subscription rate throughout the world is 30/- post free. Subscription orders may be sent to the publishers at either of the addresses given above, or placed through any newsagent or subscription agency. The price of single copies is 2/6 (3/3 by post).

Advertising. Communications and inquiries should be addressed to the Advertisement Manager at the Manchester address given above.

Remittances should be made payable to the publishers, Emmott & Co. Limited, and crossed "Midland Bank Limited"

Contributions. The Editor invites orignal contributions on mechanical subjects. Broadly the aspects covered are the design, materials, manufacture, process, management and maintenance of engineering and industrial plant and machinery. Sketches should be in black ink if possible but the lettering may be left in pencil. Photographs are welcome and so are short notes of practical experience. Payment is made for exclusive contributions. Communications should be addressed: The Editor, MECHANICAL WORLD, 31 King Street West, Manchester 3.



L.S.E. draw-out control gear is made in three standard capacities, for motors up to 12½, 35 and 90 h.p. capacity.

Provision can be made for larger motors, and for incoming and outgoing circuits, special panels, etc.

Standardized but not stereotyped—

L.S.E. CENTRALIZED DRAW-OUT CONTROL GEAR

The advantages of this type of gear should be considered in all cases of works extensions or modifications involving a number of motors. Savings in the costs of supervision, maintenance, installation and cabling may be effected, together with economy in space.

L.S.E. centralized draw-out equipment (ASTA-tested to 35 MVA) embodies a number of outstanding technical features, and is sufficiently flexible in design to enable a wide range of requirements to be met promptly and economically.

Fuller details are given in Publication 232, available from Laurence, Scott & Electromotors Ltd., Publicity Department, 376 Strand, London W.C.2.

LAURENCE, SCOTT & ELECTROMOTORS LTD.

NORWICH, NOR 85A and BRANCHES

Mechanical World — April 1960

Homogeneous Safety

AN innate response to the threat of danger is a valuable asset possessed by most people most of the time, but not by everybody all the time. The occasional failure, if it occurs in a juxtaposition of adverse circumstances, leads to an accident. The adverse circumstances are always happening but usually the awareness of danger is present for avoiding action to be taken. This can be seen on any main road, or for that matter on any pavement. The moving bodies for the most part avoid each other and steer round obstructions, except on the rare occasions when the moment of unawareness coincides with the risk.

There is another set of circumstances in which a number of people entrust their safety to others, for the time being relinquishing all control themselves. This happens in transport and the trust is first in the product of the designers, then in the judgment and knowledge of the materials specialists, then in the skill of the craftsmen, then, and more immediately, in the skill and experience of the operators, but not entirely for it rests also on the knowledge, experience and skill of those who maintain the equipment at full pitch of performance. The chain of trust is long and involved and it includes at least one necessarily imperfect factor—that of knowledge, which is admittedly never complete, though it is often adequate. There is much scope for critical appraisal—anticipating the moment when the rare but vital fault may present itself.

A third set of circumstances is when an aura of dynamism is entered deliberately. The environmental change is from the normally passive to the actively threatening. Examples are found in many industrial occupations and in hazardous sports and vigorous games. In all these the risk is either immediate, in which case training, skill and equipment may be expected to deal with it as long as they are all adequate and applied; or derivative, which generally means failure of equipment.

The conclusions are that safety depends upon fitness to cope with risk, and efficiency in designing equipment with built-in safety. The former comprises training and the acceptance and use of appropriate protective measures—clothing and the like. The latter involves critical appraisal of the hazard throughout the long train of events already mentioned. For example, disaster caused by the breaking of a single bolt goes back to the failure to recognize that so much depended on a minor constructional item. Such singularity is inappropriate to the importance of the function. Training for personal safety, particularly in industry, is similarly fundamental: there has to be early perception of the likelihood of the risk and appropriate action taken beforehand.

Safety is a fundamental subject which enters into all branches of industrial endeavour, and it demands scientific method and technological application.

LOG SHEET

Process Computer/Simulator

CERES (Control Engineering Research Electronic Simulator) delivered by General Precision Systems Limited, Aylesbury, to British Petroleum, is now in use for investigation into a wide range of dynamic problems relating to processes in oil refining, distribution and plant economics. This is the first known purchase in this country of an analogue computer of this size for use exclusively in a process industry.

In addition to its prime use as an analogue computer CERES will be used extensively as a simulator in the training of plant operators. Typical and exceptional situations which may occur in controlled refining processes can be simulated and operators trained at negligible cost in handling these situations. Pre-simulation of new processes will enable plants to be commissioned with the minimum of delay and disturbance.

The basic computer uses in all 69 high gain chopper stabilized d.c. amplifiers. A large number of potentiometers (92) is provided for trimming amplifier gains and for adjustment of problem parameters. These will be set up in the first instance using the latest type of digital voltage presentation and may later be set up automatically from punch paper tape programme.

A complete range of non linear computing elements is provided. The machine includes servo multipliers of two distinct types each with its own attributes; one type will be used for multiplication in which high response rates are required and the second where lower rates are required or for continuous integration over periods of many hours. Both provide for generation of non-linear functions.

The latest electronic techniques have been employed in the design of elements to enable straight line approximations to be made with considerable accuracy in the generation of any single-valued arbitrary functions encountered in the simulation of process control equipment.

Two patch panels are provided, each with a removable plug board and each sharing the computing elements so that the various sizes of problems can be applied with the maximum convenience. The ancillary equipment provided by BP includes recorders, XY plotters, transport lag simulators and will later include a graphic display panel for use when the computer is used as a training simulator.

The complete equipment is mounted in six standard 19 in. racks. All units of the same type are interchangeable both physically and electrically. A comprehensive switching arrangement enables the various computing elements to be monitored continuously during computation using either built-in or external displays and recorders.

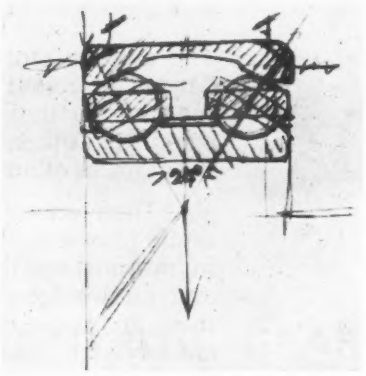
Skefko Jubilee

The only British manufacturer of all four basic types of ball and roller bearings — ball, cylindrical roller, taper roller and spherical roller — The Skefko Ball Bearing Company Limited, of Luton, Bedfordshire, celebrated its Golden Jubilee on February 7 last. To mark the occasion the company issued a special number of its house journal, *Inner Ring*, which told the company's story year by year through the half century.

Just three years before the foundation of the British Skefko business, Dr. Sven Wingquist had invented the self-aligning ball bearing. Backed by some prominent Swedish business men a company was formed to produce these new bearings. They were soon in steady demand in England and this led quickly to the British factory being set up. The British company's subsequent history has been one of continued success and expansion and of good relations with its employees. In a message broadcast throughout the factory on Monday, February 8, the company's managing director, Mr. C. U. Magnusson, announced that to celebrate the Golden Jubilee the company had set aside £100,000 for the benefit of its employees.

At the present time, as already mentioned, the company makes a comprehensive range of bearings. It is also noted for its bearing mountings—the standard plummer blocks, axleboxes and the like which are supplied in large quantities, and is equally noted for many specially designed bearings and mountings.

Dr. Sven Wingquist, inventor of the self-aligning ball bearing and founder of the SKF organization. He was Skefko's first chairman and a director for many years. Below is a reproduction of his first sketch of the self-aligning ball-bearing



LIFE OF A PEDAL.—A customer of Joseph Rhodes & Sons Limited, the press manufacturers of Wakefield, recently ordered a replacement pedal for a power press. The old part, seen here, was sent for examination; the leather sole of the operator's shoe had completely worn through the metal after long years of use. Records showed that the press had been in continuous use from the end of last century

Island Water

The first installation of a sea-water distillation unit ever made in a temperate zone has been supplied to the States of Guernsey Water Board. The purpose is to safeguard

GEAR LUBRICATION.—At left an operator is pouring liquid plastic into a tooth space between two dams to make a replica of the tooth flank surfaces. Right, a replica from a wheel at an intermediate running-in stage is being examined under the profilometer to detect surface variations resulting from service. This work is being done at the Shell Company's Thornton Research Centre, Cheshire, where a lubricant for the high load carrying case-hardened gears of warships has been developed. This same lubricant is now being beneficially used for the running-in of merchant ship reduction gearing

Guernsey's vital horticultural industry against possible drought. The plant will produce half a million gallons of fresh water a day and was designed and manufactured by G. & J. Weir Limited, Glasgow.

There were approximately 450 tons of prefabricated sections for the distillation plant and the handling and erection of this posed a major problem for the installation contractors because of a lack of adequate cranage on the island. With lifts involved of up to 20 tons, the answer was obviously a heavy duty mobile crane and to surmount the difficulty a 25 ton Coles truck-mounted crane, operated by Pickfords Heavy Haulage Service, was shipped in three parts, with its crew to Guernsey, assistance with the shipping operation being given by Steels Engineering Products Limited, who partially dismantled the crane before shipment and re-assembled it again on arrival in Guernsey. This is a new departure in crane hire procedure and probably the first time that a mobile crane of this capacity has operated on an island the size of Guernsey.

Glass Fibre Tank Cover

This 30 ft dia solid resin reinforced glass fibre cover is for an effluent settling tank at the National Smelting Company's Swansea Vale Works. It is in eight segments and a special epoxy resin/glass fibre is used to withstand vapour from SO_2 saturated liquors containing traces of other acids. Sixteen gas-tight inspection covers give access to the clarified liquor overflow weir. The picture is of final assembly at the works of Permali Limited, before delivery.

Segmental resin/glass fibre vapour resistant tank cover

Keith Blackman Exhibition

Perhaps the most interesting single display in the new permanent exhibition building at the Tottenham, London, N17 Head Office address of Keith Blackman Limited, makers of the Tornado range of fan engineering and industrial gas equipment, is a pair of propeller fans. Both were made by Keith Blackman, both are direct driven by motors made by Keith Blackman, both are of approximately 12 in. dia. Here the similarity ends for one was made in 1897, the other in 1959 and it goes without saying that design and manufacturing techniques have progressed considerably in fan and motor production over the years. The veteran fan is in fact one that was returned to Tottenham after fifty-four years continuous service in ventilating office accommodation in a town hall. It was still in working order but unsuited to a pending change in electric supply.

The new, specially built showroom is designed to show users, prospective users, trade associations and student bodies a broad cross section of the small to medium ranges of Tornado fans and ancillary equipment. These include axial and propeller fans, centrifugal fans, blowers and exhausters. The smallest fan displayed is a $1\frac{1}{2}$ in. dia blower for the cooling of valves and other electronic equipment; the largest is a 60 in. dia variable pitch axial fan impeller for general ventilating, mine ventilating and cooling purposes. Ancillary equipment is represented by welding fume exhaust units, a range of air filters, various sizes of sleeve and ball bearings produced in the company's Scottish foundries, grinding and

The section of the Keith Blackman exhibition which deals with the sales areas in the U.K., catalogue display, and photographs taken 'behind the scenes' at the company's works at Tottenham, Edmonton and Arbroath

polishing dust exhaust units and man-hole ventilators. Many exhibits including solid pvc fume removing centrifugal fans, selected from the company's stocks of standard equipment, are held available for quick deliveries.

Recent additions to the Tornado range in evidence are the new Aristocrat centrifugal fans, the Keith Blackman air circulator, and a working model of the Series TF collector of fine dry dusts which has been added to a fast expanding range of dust collecting and settling equipment.

A special display relates to equipment concerned with implementing the conditions of the Clean Air Act. This section shows a model of a combined induced draught and grit arresting fan; types of PD-KB tubes employed in tubular dust collectors made in collaboration with Prat-Daniels (Stroud) Limited, a Type AR(W) backward bladed induced draught fan impeller, and photographs of electrostatic precipitators.

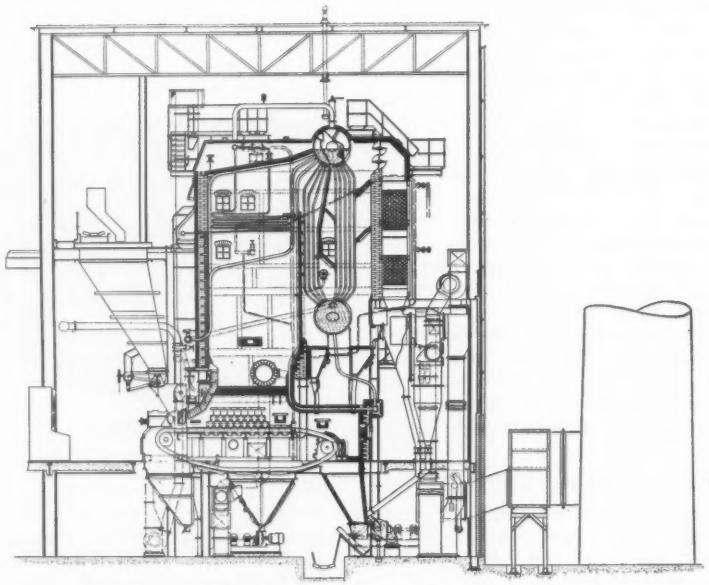
Coke Works Boilers

At the new Murton coke works of the National Coal Board in County Durham, the steam generating plant, supplied by Clarke, Chapman & Co. Limited, of Victoria Works, Gateshead, comprises three units, each with a maximum efficient rating (M.E.R.) of 20,000 lb/hr at 615 psi gauge and 815° F at the boiler outlet, from feed water entering the economizer at 200° F when burning South Hetton smalls or coke oven gas, or a combination of both.

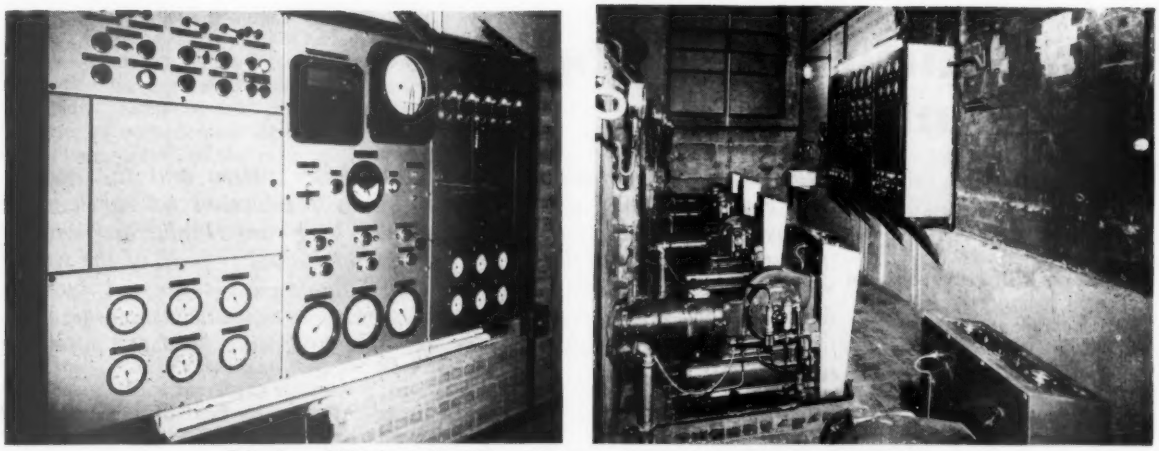
The boilers are of the bi-drum radiant-heat natural-circulation water tube type. The firing equipment for each unit comprises a travelling grate stoker supplied by International Combustion Products Limited, for solid fuel, and one Gako T.B. type gas burner fitted in each side wall of the combustion chamber. The front wall of the combustion chamber is cooled by 3¼ in. O.D. tubes at nominal pitches of 6-in. backed by a refractory wall and insulating blocks. Alternate tubes are carried across the combustion chamber from the front wall immediately below the superheater and then upwards, in front of the rear wall, into the top drum. The remaining front wall tubes continue upward and backward into the top drum, to form the front and roof of the upper chamber. The rear wall is cooled by similar tubes at pitches of 6¾ in., the bottom of the tubes being arranged horizontally to support the rear refractory arch. The boiler is completely enclosed in mild steel casings.

The hot gases from the combustion chamber flow upwards through the self-draining type superheater and through the circulating tubes between drums, the gas flow through the tubes being directed by firebrick baffles. From the boiler the gases travel downwards through the economizer, leaving at 349° F, and then through dust extraction plant of the mechanical type manufactured by James Howden & Co. Limited. The cleaned gases are extracted by an induced draught fan and are discharged into a common flue leading to the single chimney.

Feedwater at 200° F enters the economizer and is raised to 348° F. The economizer, manufactured by Senior Economisers Limited, is of welded construction having cast-iron sleeves shrunk on to the tubes to provide additional heat absorbing surface. The water leaves at the top of the economizer and is fed into the top drum, being distributed along its length by an internal pipe. It then flows down through the rear bank of circulating tubes into the bottom drum, where the greater part of the water is carried by feeder pipes to the headers at the bottom of the combustion chamber walls. This part of



Sectional arrangement of one of the three boilers at N.C.B. Murton coke works



Boiler house (right) for heating Belfast Telephone Exchange and its automatic control panel (left)

the water then continues up the tubes forming these walls and into the top drum. Water is also circulated up through the front bank of inter-drum tubes and into the top drum. Here the steam is released by a system of baffles, before passing through scrubbers into the superheater.

The saturated steam from the top drum is piped to one end of the superheater top header, which is divided into two sections by a diaphragm at the centre. The steam then flows downwards through one half of the bank elements to the lower header and along this header into the other half of the bank, through which it flows into the outlet section of the top header.

The draught plant for each unit consists of a forced draught fan, induced draught fan and secondary air fan, manufactured by James Howden & Co. Limited.

The boilers are fitted with the normal operating instrumentation and flame failure indication and warning for the gas burners.

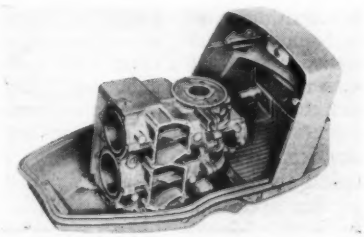
The sootblowing equipment supplied by Clyde Blowers Limited, comprises one electrically operated retractable blower with a stroke of approximately 8 ft, arranged to clean the furnace tubes and superheater, and one hand-operated multi-jet blower for cleaning the boiler circulating tubes.

The mountings and fittings are of Dewrance's manufacture, the main instruments and control panels by George Kent Limited, and Tension type feed water regulating equipment by Copes Regulators Limited.

Automatic Boiler Control

This control panel is for the fully automatic operation of the boiler house providing the heating for Belfast Telephone Exchange Building. It accommodates weather sensitive temperature regulator, smoke density indicator and alarm system, oil storage gauges, riser and return flow indicators, riser and return flow recorder, pump starters, alarm and normal running signals, etc.

The Stonebridge "Sigma" weather sensitive unit controls on/off operation of five Clyde Fuel Systems pressure jet burners via a time delay unit which starts up burners at one minute intervals. The cabinets on the burners include Stonebridge photo-electric flame failure and starting sequence controls. The panel was supplied by The Stonebridge Electrical Company Limited, of 6 Queen Anne's Gate, London SW1, through Brightside Heating & Engineering Company Limited, Belfast.



ENGINE BLOCK CASTING.—This aluminium pressure diecasting for the Perkins 35 hp outboard engine with the iron liners cast in requires very little machine finishing. It is made by J. V. Murcott & Sons Limited, Aston, Birmingham, who have a patented method of making hollow aluminium pressure diecastings for such work as cylinder heads requiring water and air passages

Ethylene Pipe-line

A wide variety of chemicals, plastics and synthetic rubbers and fibres are now made from petroleum derivatives such as ethylene. For their new Severnside works in Gloucestershire, Imperial Chemical Industries Limited are to draw a supply of ethylene from the Esso Refinery at Fawley and this will be done by a 75-mile pipe-line linking the two plants. The pipe, which will be buried to a minimum depth of 30 in., will cost about £800,000, and extensions to the £10 million Fawley refinery to provide this and similar supplies will require a further £5½ million expenditure on new equipment, including another steam cracker.

This is the second long pipe-line project of the Esso Company, the first being for the supply of fuel direct to London airport.

Continuous Casting Plant

The continuous casting plant to be installed by The Steel Company of Wales Limited as part of the latest development programme will be the largest of its type outside the U.S.S.R. A twin-strand unit, it will produce slabs from 27 in. × 6 in. to 48 in. × 9 in. and up to 21 ft in length from basic Bessemer steel. The BISRA process will be used, and the plant will be supplied by Continuous Casting Company Limited, Weybridge, who are licensees for the BISRA continuous casting processes and are an association of Campbell, Gifford & Morton Limited, Davy & United Engineering Company Limited, and Newton Chambers & Co. Limited.

Application Aspects of Hydraulic Fluids

The fluid is the lifeblood of any hydraulic system and the correct choice of fluid not only gives optimum production or service but represents the most economic cost in the long run. Haphazard topping up with non-standard fluids, the use of a high-quality fluid of the wrong viscosity, the employment of "cheap" fluids—all represent hazards which could—and should—be avoided. This article discusses the main factors associated with the selection of a hydraulic fluid for optimum service

THE production or service capabilities of any hydraulic equipment are closely linked to the characteristics of the fluid employed in the system. As a generalization, the right fluid is always the cheapest in the long run, giving both better quality and quantity of production (or service) and minimizing both power consumption and maintenance cost. An inferior fluid is almost inevitably a source of costly trouble, sooner or later.

A majority of hydraulic systems employ mineral oil fluids, although water, water-base and synthetic fluids have their specific applications. Water has the advantage of being negligible in cost and therefore particularly attractive in systems where fluid losses may be high. It is also a "safe" fluid from the point of view of contamination and fire risk resulting from a burst. Mineral oils have the specific advantage of being inherently non-corrosive and can be formulated with high chemical stability and excellent lubricating properties. Water-base fluids provide a non-inflammable medium with better overall properties than ordinary water and may be particularly attractive where the fire risk is high, as on die-casting machines, aircraft hydraulics, etc. Synthetic fluids range from those with non-inflammable characteristics to others formulated for high-temperature operation. All are more costly than normal mineral oil fluids and are produced for specific rather than general application.

It is a requirement of any hydraulic fluid that it should be capable of performing a number of duties. Apart from pure pressure transmission it must also provide lubrication for pumps, valves and pistons, remain chemically inert and be stable physically. All these factors have become more and more important—even critical—with modern hydraulic machines which may be called upon to work within very fine limits at high speeds, and often at very high pressures.

Quick machine response with accurate motions and feeds is dependent on complete chemical and physical stability of the fluid. High chemical stability is essential to resist oxidation which would otherwise result in the formation of sludge or gummy deposits. Even before actual oxidation products may be detectable, fluids which are not stable will tend to thicken and become sluggish in service under constant circulation and churning in the presence of oxygen, retarding the operating cycle and slowing production. Thus the usable life of a fluid is determined by its chemical stability.

Due consideration must also be given to the operating conditions. Oxidation is accelerated by high-service temperatures. Whilst the highest-service temperature in the majority of hydraulic machines may not exceed 120°–130° F, in some cases the fluid may be subjected to temperatures as high as 200°–250° F in part of the work cycle. In such cases it may well prove economical to provide some form of cooling to extend the life of the fluid for no practicable fluid has an indefinite life.

Adequate filtering is also an important feature for the presence of dust or other contaminants in the system will tend to promote oxidation. In some modern high-pressure systems, fluid velocities of several hundred miles per hour may be experienced in certain parts of the system giving rise to a considerable degree of erosion even on hardened and polished surfaces. The degree of contamination is then readily accelerated by the abrasive potential of such erosion particles if allowed to circulate.

Apart from control of chemical composition, oxidation resistance of mineral oils can be improved by the inclusion of anti-oxidant additives (usually up to 2% maximum), which is normal practice for oil-base fluids designed for high-operating temperatures and pressures. These additives have a preferential attraction for oxygen and thus until themselves completely oxidized, maintain the chemical stability of the basic fluid. From then on, of course, the oil is subject to normal oxidation consistent with its composition. The difference in life between an additive oil and an oil without anti-oxidant additive is therefore at least the life of the additive, provided no side chemical effects are set up.

Resistance to oxidation also governs, to some extent, the demulsibility of an oil, or its ability to separate quickly and completely from water rather than mix with it in the form of an emulsion. Such emulsions can interfere with the operation of valves, etc., promote chatter or otherwise upset accurate machine response. Erosion particles of ferrous metals in the form of finely divided iron oxides and hydroxide have a marked emulsifying effect in tending to promote the formation of metallic soaps by chemical reaction with the oil—soap being a recognized emulsifying agent. Stable water-oil emulsions, once formed, may range from thin slimes to thick pastes and may necessitate shut-down of the system for a complete cleaning.

Foaming can also be another source of trouble, although this is of a mechanical nature and largely dependent on the mechanical design of the system. It is caused by air in solution with the fluid. At normal temperatures and pressures, the solubility of air in oil may range up to 8%. More air may be entrained at higher pressures, to be discharged again in the form of fine bubbles at lower pressures or expansion points.

In a completely closed system the quantity of air is, or should be limited to that which is present in the fluid

when initially filled, provided the system is well vented during the filling operation. Where the oil is returned to an open tank or comes into contact with air as in an air-loaded accumulator, additional entrainment may take place. Adequate and proper venting then becomes a matter of considerable significance and, in particular, excessive agitation of the oil must be avoided whenever possible.

The lubricating properties of a hydraulic fluid are dependent both on its lubricity and film strength. Particularly in high-pressure systems, the fluid film is usually very thin and normally subjected to both pressure and wiping action. Thus conditions are approaching boundary lubrication. Maintenance of a satisfactory film depends largely on the viscosity of the fluid as a measure of its resistance to extrusion from the working clearance. At the same time the shear strength of the fluid must be suitable for being pumped at the required pressure without suffering from shear breakdown.

Lack of film strength will inevitably result in high friction and excessive wear, leading to sticking or chatter of pumps, valves, cylinders, etc., as well as increased power consumption.

The degree of sealing also depends on the viscosity of the fluid. Oil of too low a viscosity will leak at an excessive rate, producing increased pump slip and generating heat—a direct power wastage. Excessive friction through lack of lubricity will also result in heat, thinning an oil of apparently the right viscosity to produce the same effects. This may result from the fluid itself lacking the desirable lubricating properties or breaking down of the film which, once disrupted, cannot readily be reformed.

FAULT FINDING CHART

Fault	Possible cause	Action or Remedy
Oil leakage	Worn packing	Replace
	Damaged packing	Replace
	Leaky joints	Check joints for tightness.
	Oil viscosity too low	(a) Check viscosity against recommendations (b) Check working temperature of fluid.
Excessive heating in system	Clogged lines.	Check, clear or renew as necessary.
	Pump not properly off-loaded	Check valve operation and position.
	Internal leakage	Check packings, etc.
	Lines too small	Check flow velocities.
	Reservoir too small	Check capacity against requirements
	Insufficient radiant cooling	Provide oil-cooler
Excessive heating in pump unit	Fluid viscosity too high	Check against specification.
	Internal leakage	(a) Fluid viscosity too low—check. (b) Check for excessive wear.
	Relief valve wrongly set	Check against recommended maximum pressure
	Internal friction	(a) Lack of lubrication—check fluid. (b) Insufficient working clearances in pump (e.g. assembled too tightly)
	Leaking valves	Check and repair.
	Fluid temperature too high	Check. Fit cooler, if necessary, in system.
Pump Breakage	Excessive operating pressure.	Check against specification.
	Lack of adequate lubrication	Check against specification.
	Lack of fluid	Check system for restrictions, reservoir level. etc.
	Entrapped contaminant particle	Check filter efficiency and position.
	Improper assembly	Follow manufacturers' recommendations.
Pump delivery failure	Lack of fluid	Check fluid level in reservoir.
	Intake line clogged	Check and clear.
	Filter clogged	Clean or replace element.
	Air leak	Check and remedy.
	Contaminant in pump	Dismantle and clean.
	Broken part(s)	Check and replace.
	Improper assembly	e.g. with wrong direction of rotation.
Pump fails to prime	Insufficient speed (vane type)	Check against specification.
	Fluid viscosity too high	Check against specification.
	Broken parts	Check and replace.
Pump noisy	Clogged lines	Check and clear.
	Air leaks	Check and remedy.
	Air vent clogged	Check and provide proper breathing in reservoir.
	Fluid viscosity wrong	Check against specification.
	Mechanical misalignment	Check and re-align.
	Foreign matter in pump	Dismantle and clean.
	Worn parts	Replace as necessary.
	Pump speed too high	Check against specification.

Oil of too high a viscosity can also fail as a lubricant by not being able to penetrate the clearance spaces and spread quickly enough to form a film—i.e., it may promote too effective a seal. Purely on a power transmission basis, too, a thick oil is inferior in performance to a thin oil. Thus the correct viscosity minimizes slippage and ensures a proper and adequate oil flow, the lubricity then being determined by the lubricating properties and film strength of the fluid.

Water is a poor lubricant and the non-flammable water-base fluids also suffer in this respect to some extent. These fluids consist, basically, of water-glycol mixtures (water content 35–60%) plus a thickening agent as a control on the viscosity and additives for improved lubricity, and wear- and corrosion-resistance. The viscosity can be matched to pump requirements by adjusting the proportion of the thickening agent employed—generally fairly high for industrial applications but low for aircraft hydraulic systems. The viscosity of water-base fluids tends to decrease quite rapidly at high temperatures —e.g., above about 120° F. The lubricating properties of ordinary water can also be improved with additives in the form of soluble oils, although these are primarily added as corrosion inhibitors.

Lubricating properties of synthetic fluids may vary from poor to very good. Ester base and halogenated petroleum fluids have an excellent performance in this respect, with very high film strength, Silicone fluids, developed specifically for high-temperature service, have so far tended to exhibit low mechanical strength. Suffice it to say that in the aircraft field, where hydraulic requirements are most exacting, satisfactory performance has been achieved both with water-base fluids and ester base fluids, the latter in particular now being widely specified for commercial aircraft use. Water-base non-flammable fluids of similar types have also come into increasing use in industrial hydraulic machines. Water-base fluids also have certain favourable characteristics for more general application—e.g., the higher specific heat means that a water-base system will normally tend to operate at a lower fluid temperature than a comparable oil system; also low temperature viscosity characteristics are generally favourable, minimizing "warm-up" time.

The variation of viscosity with temperature is an important characteristic of a hydraulic fluid. Viscosity invariably tends to decrease with increasing temperature and increase with decreasing temperature. To maintain maximum pump capacity with minimum power consumption the viscosity of the fluid is matched to the design of the pump, logically at the operating temperature of the fluid. The fluid viscosity specified for any particular application has thus to compromise between efficient transmission of power (low viscosity) and adequate viscosity for efficient sealing and lubrication. Mineral oil fluids for industrial hydraulics have viscosities ranging from about 22·5 to 175 centistokes at 70° F. Aircraft mineral base fluids are required to have a minimum viscosity of 10 centistokes at 130° F and a maximum viscosity of 500 centistokes at – 40°F.

The extent of change of viscosity with temperature can be expressed as the viscosity index, a high viscosity index denoting a small change in viscosity with temperature. In the case of mineral oils the viscosity index is usually of the order 80–100, but in the case of water-base and synthetic fluids may be as high as 150. A high viscosity index means quick production after starting up, with a minimum warm-up period and minimum wear starting from cold.

The importance of the operating temperature of the system is often overlooked. Ideally, for any system there will be an optimum working temperature consistent with minimum slip and leakage and optimum lubrication, but in practice the working temperature is not necessarily stable or controllable. The viscosity of the fluid itself, to a large extent, governs the system temperature by virtue of its internal fluid friction when in motion. Thus fluid viscosity must be based on system design as well as pump specification. As a generalization, one would select a low viscosity fluid for a system not subject to external heating so that the working temperature of the system will be kept low. Where external heating effects may be present, then the initial oil viscosity will have to be higher. Hence the rather wide range of typical viscosity figures quoted above for industrial hydraulics.

Pumps with sliding valve surfaces generally require a rather more viscous oil for sealing without excessive leakage than those with seated valves. Equally, heavy-duty gear pumps may require a heavy oil for adequate sealing but piston pumps and light duty vane, gear and screw type pumps are normally specified for use with light oils. Light oils are consistent with quick response and ready flow. Heavier oils offer a high resistance to leakage at the expense of more power for circulating them through pipes, valves and orifices. Pressure drop is directly related to the fluid viscosity, and thus machine efficiency. Selection of the proper fluid viscosity to match the pump is therefore imperative for most efficient machine operation.

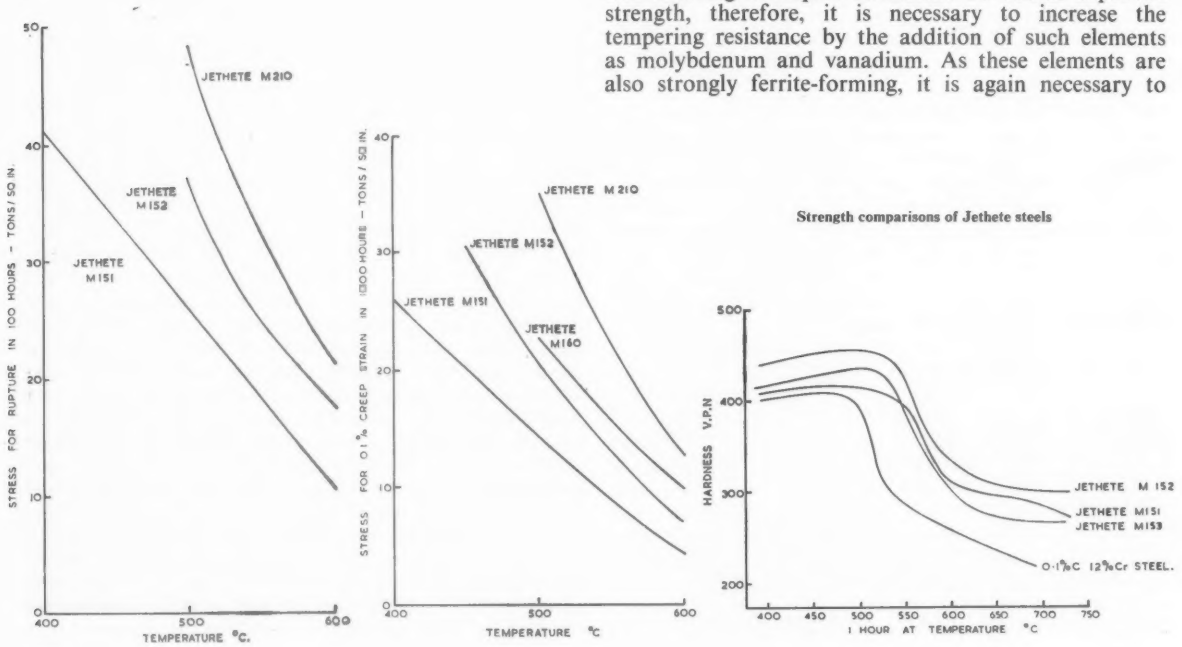
High Strength Stainless Steel for High Temperature

For some years, the research and development department of The United Steel Companies Limited, has been working in collaboration with Samuel Fox and Company Limited, a United Steel subsidiary, in the development of a range of high strength stainless steels for elevated temperature service.

This work, which has led to the introduction of the "Jethete" series of steels, was initiated because of the limitations of existing steels in providing adequate mechanical strength at elevated temperatures combined with good corrosion resistance. It is possible, for example, to obtain a wide variety of mechanical properties from low alloy steels but they are insufficiently resistant to corrosion. Austenitic stainless steels of the 8% nickel, 18% chromium type have a good corrosion resistance but suffer from the major disadvantage of low mechanical strength. Similar considerations apply to fully ferritic steels, where ductility is also poor. By cold working, it is possible to improve the mechanical strength of both austenitic and fully ferritic stainless steels, but the higher properties cannot be retained at elevated temperatures.

High strength can be allied to corrosion resistance, however, by means of the transformable group of stainless steels. The most widely used steel in this group is the low carbon 12% chromium steel. This has a reasonable combination of mechanical properties, but is deficient in strength after tempering at 650° C (which might be required after welding) and has relatively poor impact properties. Despite these limitations, this steel was selected as the starting point in the Jethete series.

One of the difficulties with the 12% chromium steel is that it is near the border line of structural stability. Chromium is a strong ferrite-forming element, and if appreciable amounts of ferrite are formed in the structure, the hardening effect is lost. By increasing the carbon content, ferrite formation can be prevented, but only at the expense of making the steel unsuitable for welding and reducing its impact resistance. To obtain improved strength, therefore, it is necessary to increase the tempering resistance by the addition of such elements as molybdenum and vanadium. As these elements are also strongly ferrite-forming, it is again necessary to



Strength comparisons of Jethete steels

balance the structure. For this reason, the Jethete series of steels are low carbon 12% chromium-nickel steels, containing additions of molybdenum, vanadium, niobium and other elements as may be required to produce the desired properties.

Jethete M.151 is a low carbon 12% Cr-Ni-Mo-V composition, in which the composition is controlled so that the structure is fully austenitic at solution and welding temperatures. On the other hand, the tempering resistance is not so great as to prevent softening prior to fabrication. The major use of Jethete M.151 is in sheet form, where it must be capable of softening for fabrication by pressing, but the full mechanical properties can be recovered by a relatively simple heat treatment, which does not involve too high a solution temperature.

Jethete M.152 is a development from Jethete M.151, having a similar composition but with high impact properties and a low transition temperature. The improved impact level is advantageous when producing large sections.

While Jethete M.152 represents an appreciably increased strength level compared with the straight 12% chromium steels, there are applications where an intermediate strength will give satisfactory performance. Jethete M.153 was introduced for this purpose. It is a 12% Cr-Ni-Mo composition, with higher impact properties and a slightly lower cost than Jethete M.152.

The high temperature properties of the 12% chromium steels are quite reasonable in the 400°–500° C temperature range. A need arose for improving these properties, however, particularly for use in aircraft turbines, and Jethete M.160 was developed to meet this demand. This is a 12% Cr-Ni-Mo-V-Nb composition, and the niobium addition provides the improved high temperature strength.

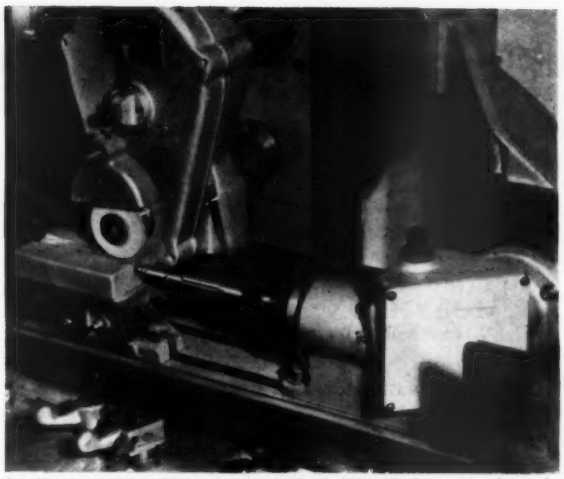
With further increases in aircraft engine temperatures, the strength of Jethete M.160 becomes inadequate, and accordingly Jethete M.210 was developed. This is a 12% Cr-Ni-Mo-Co-B composition, and the latest in the Jethete series, although development work continues towards the production of other high-strength stainless steels with still further improved properties.

Much of this work has been undertaken initially in response to problems encountered in the field of jet aircraft and guided missiles, and the aircraft industry is a large user of the Jethete series of steels. Increasing interest is now being shown by other industries with analogous problems, however, and these steels are being employed in growing quantities for such applications as the low pressure turbine blades in power stations.

Spline Grinding Attachment

The standard Model 540 Jones & Shipman surface grinder can now be provided with special equipment for grinding the radius at the bottom of 4-spline shafts with a formed wheel. The component is automatically indexed through 90° each time the machine table moves to the right and brings the grinding wheel clear of the splines. As the clearance between the splines and the plain portion of the components is very limited a small diameter wheel is necessary and a high-speed attachment carrying a 2½ in. dia wheel is attached to the wheel head in lieu of the normal size wheel.

The work is mounted on centres between a tailstock on the left hand side of the table and the automatic



Grinding the radius at the bottom of a 4-splined shaft with the new attachment for the Jones & Shipman Model 540 surface grinder

indexing head on the right. The indexing head is actuated by a cam mounted on the side of the wheel head column which contacts a ratchet lever and indexes the work spindle through 90°. A plunger engaging an index wheel retains the spindle in position during the grinding operation and a driving plate on the front of the index head spindle engages a driver attached to the work.

To enable the components to be loaded between centres with the bottom of the spline in correct relation to the wheel, a loading device is used which ensures that the driver is correctly positioned for the purpose. A wheel truing device is included consisting of a mandrel carrying a diamond set to the required radius and which can be mounted between centres and swung through the necessary arc of movement to form the required radius in the periphery of the wheel. Setting collars are provided to enable the diamond to be set to the required degree of accuracy.

New Higgs Motor

Higgs Motors Limited, Witton, Birmingham 6, have introduced a new range of totally-enclosed fan-cooled motors complying with B.S. Draft Specification A(ELE) 1629 which are dimensionally interchangeable with British Standard ventilated motors to B.S. 2960. These machines comply with B.S. 2613 for Class E insulation and give a similar horse-power output. The motors are smaller in size and lighter in weight than the corresponding totally-enclosed fan-cooled motor to B.S. 2083 and likewise are lower in price.

The foot-mounted range has been developed up to 7½ hp at 1500 rpm but at an early date it is anticipated that machines will be available up to 40 hp. Other derivatives such as flanged, foot and flanged or totally-enclosed non-ventilated types will follow.

With the exception of the smallest frame the stator housing is ribbed on the outside. This increases the surface area which rapidly dissipates heat from the motor. This construction also gives considerable strength to the shell design. Machines of this type are suitable for use in dirty or fluffy atmospheres.

Design of an Effluent Gas Scrubbing Tower

Various devices for the scrubbing of effluent gas to remove solid and gaseous pollution are viewed and a design considered for the scrubber for a particular chemical effluent of this type. One application is to existing boiler plants to comply with the Clean Air Act and to secure by-products

By F. MOLYNEUX, Ph.D., B.Sc.(Lond.), B.Sc.(Eng.), A.M.I.Mech.E., A.M.I.Chem.E.,
Senior Lecturer, Department of Chemical Engineering, Birkenhead College of Technology.

THE emission of effluent gas from chemical works has been controlled by the Alkali Act since its introduction in 1906. This Act has regulated the emission of SO_2, H_2S and similar noxious gases arising from chemical processes but has applied strictly to chemical works registered under the Act.

A new stage has now been entered by the introduction of the Clean Air Act (1956) in June this year, whereby it is now a punishable offence to emit effluent into the atmosphere with a density exceeding that of the Ringelman Chart No. 2/3. Whilst this strictly controls the emission of solid matter it is generally recognized that most of the industrial damage is not due to this but rather to the gaseous content of the effluent emitted, particularly SO_2. The trend can therefore be observed whereby all practicable steps will have to be taken to reduce the emission to a lower figure both on solid and noxious gas emission. Several effective methods of performing this reduction are available and have been listed as:

(1) Waste dispersal by use of stacks
(2) Absorbers or scrubbers in-
(3) Incineration
(4) Catalytic combustion
(5) Adsorption.

The first method is that generally adopted but its abuse has in effect given rise to the present Act since the limit to the amount of pollution that the air can absorb and diffuse has been reached in most industrial localities.

In effect, therefore, what is required is a combination of methods (1) and (2) or absorption and scrubbing followed by high-level dispersal.

This resolves itself into the problem of many chemical manufacturers, who, for economic reasons wish to recover from the plant gaseous effluent both valuable solid and soluble gaseous by-products.

The general method adopted by most firms is that of:

(1) Scrubbing the gases prior to stack exit with some liquid in which the noxious or valuable by-product gas is soluble. Unfortunately this recovers the solid by-product in a wet form. The cleaned gases are then discharged via a stack of predetermined height and subject to local bye-laws and regulations.

(2) Treatment of the effluent gas in electrostatic precipitators. These can be either wet or dry but usually they are required to produce the solid by-product in a dry state and are therefore operated dry, followed by liquid scrubbing prior to stack discharge. The capital cost of method (2) is, however, so great that unless the cost of the recovered solid is sufficient to warrant the capital outlay to give an increased efficiency of recovery, method (1) is that usually adopted.

Absorbers or scrubbers

These can be listed in order of preference as being of the following types:

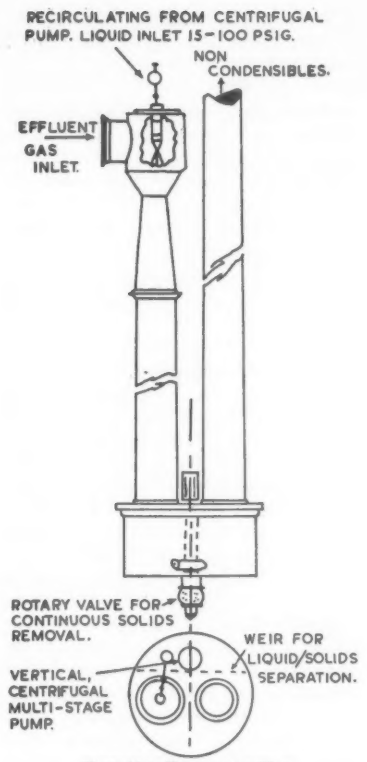
(1) Packed towers
(2) Plate towers
(3) Spray towers
(4) Agitated tanks
(5) Water jet scrubbers and falling film absorber scrubbers.

Since the problem in most chemical works is that of absorbing a noxious gas from the effluent to satisfy the Alkali Act, most absorption equipment is designed on this basis. The rate at which a soluble gas passes into solution is usually slow and the liquid must therefore be prepared by physical means so that the maximum possible amount of surface is provided for transfer from the gas phase. This is accomplished by a variety of means as listed above consisting of atomization (spray towers), tower packing (packed towers), sieve and bubble plates (plate towers), and agitation. The last method (5) has suffered in practice because of this lack of provision of enhanced surface and its application somewhat neglected. If, however, the combined problem of absorption and dust removal is considered the picture is completely reversed since the packed tower and plate tower have both very poor performances on this double duty. In addition, it is frequently found that there is insufficient pressure head available to overcome the high pressure loss in passage through the packed or plate tower. This is particularly the case with processes which must be operated under a slight vacuum or where the only draught is provided by the temperature of the waste gas in the exit stack. It is in these cases that use of method (5) is sometimes the only permissible one.

Water jet scrubbers

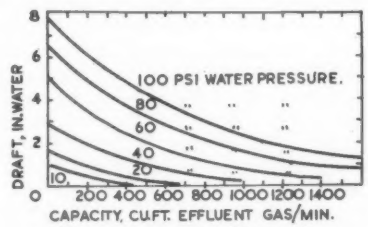
Water jet scrubbers are versatile because they create a draught and by absorption remove the soluble gas from the effluent meanwhile removing the solid by entrainment. The operation of this scrubber absorber is illustrated on the accompanying sketch. The liquid (usually water) used to absorb and scrub the gas, enters the vertical pipe at the top via a nozzle. This nozzle provides a high-velocity jet whose entry into the venturi throat induces the gas or vapour and solid into the upper side of the venturi. Condensation and entrainment of solids takes place in the liquid together with absorption of the soluble gas. The discharge enters a tank where the solids and liquid can be separated, the scrubbed effluent gas being vented via a stack.

Most materials of construction can be used for the extremely simple fabrication, some of those used including cast-iron, bronze, stoneware, Haveg, stainless steel, and Karbate. The author had experience of the highly successful use of this



Venturi jet effluent gas scrubber

equipment constructed in rubber-lined mild steel for the scrubbing of SO_2 and micron size particles of pyrites from the exits of pyrites dryers and the vents of closed circuit ball mills grinding flotation pyrites. The gas and vapour capacity of water jet scrubbers varies with the water pressure, the draught required and the solubility of the gases and vapours in the liquid used.



12 in. water jet venturi scrubber capacity

Tab'e 1.—RELATIVE CAPACITIES

Jet size, in.	Capacity Ratios
3 in.	0·020
4 in.	0·042
6 in.	0·134
8 in.	0·266
10 in.	0·496
12 in.	1·000
14 in.	1·440
16 in.	1·785
18 in.	2·500
24 in.	5·130
30 in.	8·100
36 in.	12·000
42 in.	15·950
48 in.	23·000
60 in.	40·900

Table I illustrates the capacity of a 12 in Schutte-Köerting water jet scrubber and compares other jet sizes to the 12 in. Thus from the table it can be estimated that a water jet scrubber with a 10 in jet and a water pressure of 80 psig can handle 500 cfm of gas at 1 in. W.G. suction. The disadvantages of the water jet scrubbers are, however, considerable. The quantity of liquid required for a limited gas flow is very considerable and since the contact time is short, the absorption efficiency is low. The efficiency of conversion of pump power to draught is also extremely low and with these disadvantages it is usually difficult to justify the use of this type of scrubber under any but the most rigorous conditions.

As a development of this and to overcome the above limitations the falling film absorber scrubber has been developed largely based on experience gained in the direct contact condenser field.

Falling film absorber scrubber

Due to the limited surface provided by the film of liquid on the walls of the scrubber, the absorption efficiency is so low that its use in the industrial field has been restricted to the laboratory and pilot plant where it is commonly used to determine process variables for use in packed or plate tower design. In the present usage, however, it can be combined with the exit stack which must be provided in every case and the height available thereby extended to several times that of the equivalent packed tower. In this tower also, contrary to the jet scrubber described previously, the absorption process is carried out counter current, providing maximum absorption with minimum quantity of liquid. Effective cooling of the gas is also provided by the transfer of heat from the gas to the liquid film, thus enabling condensation of solid to take place prior to contact with the liquid stream. The mechanism of gas absorption is considered to follow the two-film theory of Whitman, the soluble gas diffusing in series through a film of the inert gas and a film of the liquid before it can dissolve in the main body of liquid. This rate of diffusion is governed by the gas film and liquid film coefft, the area for transfer and the driving force available.

Normally the gas film coefft is controlling when this type of tower is most effective.

If k_g = gas film coefft in lb mols absorbed per hr per sq ft per atmosphere pressure difference

k_l = liquid film coefft lb mols per hr per sq ft per atmosphere pressure difference

then $k_g = (D_g P)/(R.T.\ B_g P_m)$

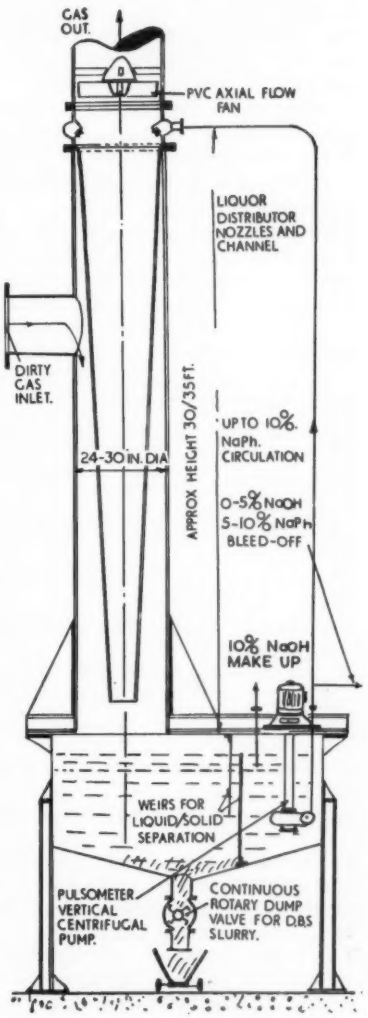
$= b_g/(B_b P_m)$

Where D_g = gas diffusivity ft^2/hr

$$= \frac{0{\cdot}0166\ (T)^{3/2}}{P(V_A^{1/3} + V_B^{1/3})^2} \times (1/M_A + 1/M_B)^{\frac{1}{2}}$$

Scrubbing exit gas from caustic fusion pots (synthetic phenol manufacture)

The flow of gas is 200 cfm at a temperature of 350°F. The temperature is reduced to 100°F in the scrubber and the steam condensed and solids such as diphenyl sulphone are also condensed and scrubbed out. The condensation of the steam will



Schematic diagram of effluent gas scrubber

remove 9/10 of the water content and the total pressure will be reduced from 770 mm to 200 mm in the inlet gas space. This additional vacuum helps to extract the effluent gas.

The total non-condensible gas flow:
$200 \times (200/770) \times (1/60) = 0{\cdot}870$ cu ft/sec
The mean diameter of conical section = 9 in.
The velocity = Q/A =
$(0{\cdot}870 \times 4 \times 144)/(5 \times 81)$
= 2 ft/sec.

It has been stated that for a wetted wall column the gas velocity should not exceed 10–20 ft/sec and that the optimum liquid wetting rate is 0·4–1·0 cm³/sec cm. This gives a maximum liquid flow of 60 gph on the above mean diameter but due to the fact that the liquid is introduced via tangential jets, a vortex motion is imparted to the liquid film and this is stabilized by the conical shape of the tube. A high wetting rate is then assumed of 10·0 cm³/sec cm to give a flow of 600 gph liquor.

The tower is designed on the basis of the absorption of phenol contained in the effluent gas stream.

1. The mol fraction of phenol in entering gas = 0·02

2. The partial pressure of phenol in entering gas at a temperature of 350°F and pressure 770 mm
= $(0{\cdot}02 \times 770)/760 = 0{\cdot}021$ atmos.

3. The mol fraction of phenol in exit gas = 0·00875

4. The partial pressure of phenol in exit gas = 0·002 atmos.

5. The weight of phenol absorbed per hour = $[(94 \times 200 \times 2 \times 9)/(100 \times 10)] \times (60/378) \times (520/810)$
= 34·5 lb/hr

6. Log mean partial press difference
$[(P_{gi} - P_{ei}) - (P_{go} - P_{eo})]/\{2{\cdot}3 \log_{10} [(P_g - P_{ei})/(P_{go} - P_{eo})]\}$
$=[(0{\cdot}02 - 0{\cdot}001) - (0{\cdot}002 - 0{\cdot}0009)]/[2{\cdot}3 \log(0{\cdot}019/0{\cdot}0011)]$
$= 0{\cdot}0179/2{\cdot}3 \log 17 = 0{\cdot}0064$ atmos.

7. D_g = diffusion coefft ft²/hr
$=[0{\cdot}0166 \times T^{3/2}]/[P(V_p^{1/3} + V_i^{1/3})^2 (1/M_p + 1/M_i)^{1/2}]$
This is of course the Gilliland equation.

V_p = Molecular volume, phenol 123·2
V_i = Molecular volume, inert gas 29·9
M_p = Molecular weight, phenol 94
M_i = Mole weight, inert 29
T = Temp. gas °K, average 38°C 273 + 38 = 311°K
P = Average pressure of gas = 0·25 atmos.

$D_g = [0{\cdot}0166 \times (311)^{3/2}]/[0{\cdot}25 (123^{1/3} + 29{\cdot}9^{1/3})^2 (1/94 + 1/29)^{1/2}]$
$= 0{\cdot}16$.

For wetted wall towers the equivalent gas film thickness has been correlated by the following equation, all the groups being dimensionless
$d/B_g = 0.023 (dv\rho/\mu)^{0{\cdot}83} (\mu/\rho D_G)^{0{\cdot}44}$

μ = Average viscosity of gas at 100°F, ft, in., hr units
= 2·42 (viscosity of inert gas in centipoise × wt fraction + viscosity of phenol in centipoise + wt fraction)
$= 2{\cdot}42 (0{\cdot}0179 \times 48/82{\cdot}5) + (0{\cdot}008 \times 34{\cdot}5/82{\cdot}5)$
$= 2{\cdot}42 \times 0{\cdot}0138 = 0{\cdot}0335$

ρ = Average density = MP/RT

M = Average molecular weight of gas
= (Average weight of gas per hr/lb)/(Average lb/mols of gas/hr)
= (lb inert/hr + lb phenol/hr)/(mols inert/hr + av. mols phenol/hr)
$M = 98/(1{\cdot}66 \times 0{\cdot}425) = 98/2{\cdot}085$
= 47

$\rho = (47 \times 0{\cdot}25)/(0{\cdot}73 \times 560)$
= 0·029 lb/cu ft

Reynolds Group
$(dv\rho/\mu)^{0{\cdot}83}$
$= [9/12 \times (2 \times 3600 \times 0{\cdot}029)/(2{\cdot}42 \times 0{\cdot}0138)]^{0{\cdot}83}$
$= 4700^{0{\cdot}83} = 1122$

Schmidt Group
$(\mu/\rho D_g)^{0{\cdot}44}$
$= \left(\frac{2{\cdot}42 \times 0{\cdot}0138}{0{\cdot}029 \times 1{\cdot}16}\right)^{0{\cdot}44} = 1{\cdot}0$

Then $d/B_g = 0{\cdot}023 \times 112 \times 1{\cdot}0 = 26$

K_g = Overall transfer coefft. lb mols/hr ft², atmos.
$= (D_g.P)/(B_g.RT.pm)$

D_g = Diffusion coefft, ft²/hr = 1·16
P = Average press of gas, atmos. = 1·0 atmos.
R. = Gas constant, atmos, ft²/lb mol °R = 0·73
T = Gas temperature, °R = 100 + 460 = 560
pm = Mean partial pressure inert gas in film
B_g = Gas film thickness, ft
d = Tower diameter, mean of top and bottom, ft

$K_g = (1{\cdot}16 \times 1{\cdot}0 \times 26 \times 12)/(9 \times 0{\cdot}73 \times 560 \times 0{\cdot}141)$
= 0·7

Since N_L = lb mols phenol absorbed per hr
$= K_g . A . \Delta . pm$
$= K_g . \pi . d_m . h . \Delta . pm$

h = height column, ft
$= (34{\cdot}5 \times 12)/(\pi \times 94 \times 0{\cdot}7 \times 9 \times 0{\cdot}0064)$
= 35 ft.

The height of a transfer unit, H.T.U., is given by the Chilton Colburn equation:

$H.T.U. = 10{\cdot}9\, d\, (u/\rho D_G)^{0{\cdot}67} (d\, v\rho/u)^{0{\cdot}2}$
$= 10{\cdot}9 \times (9/12) \times 1{\cdot}0 \times 5{\cdot}1$
= 40·2 ft.

This means that just under one transfer unit is required for the adsorption.

Materials of construction

The tower was modified from the original mild steel exit stack and the modifications were fabricated in mild steel. In order to combat corrosion due to acidity in the incoming gas, the gas space was coated with Epikote resin which withstood the temperatures and weak acid conditions to a moderate extent. The solution is to have the mild steel fabricated sections capable of insertion one inside the other and to have these sections coated with acid-resisting vitreous enamel on the inside of the outer tube and the outside of the inner conical tube. This has been found to resist completely this particular type of corrosion and abrasion.

The liquor inlet nozzles require making as removable nozzles with a filter protecting the orifice against blockage or the provision of cleaning-out caps. Access is required both for this and for the maintenance of the extract fan motor. A considerable height of column is required for any effective absorption but since this is generally provided in any case as an exit fume stack, the incorporation of the wetted wall cone of the length required is no great disability.

Condensation of 90% of the steam in the gaseous effluent takes place by transference of the heat via the metal partition wall to the film of caustic liquor. This heat is continuously removed from the liquor in the sump by cooling coils.

The diphenyl sulphone which is completely insoluble in caustic solutions is separated out in the sump and is continuously removed via the rotary liquid sealed valve in the base as a slurry containing 20% caustic phenate in the proportions circulating.

Conclusion

The statement is made by Professor M. W. Thring that although hand-fired coal-burning furnaces can be operated at high efficiency, practical experience demonstrated that efficient

and suitable mechanical appliances, properly operated are necessary in order to achieve the necessary standard of smokeless combustion. This categoric statement that mechanical firing is the only answer to smoke pollution from boilers is in full accord with the policy of the more enlightened corporations such as Manchester which has insisted since 1946 that in all new installations burning bituminous coal, mechanical firing only must be used.

Self-evident though this may be it is a bitter blow to the older chemical companies operating batteries of Lancashire boilers in the original state as installed some sixty years ago. The expenditure to convert to mechanical firing can hardly cost less than £1,000 per boiler and would not be reflected in a corresponding saving in fuel or efficiency. It has been fairly well established that smoke emission is largely due to the incomplete combustion of the volatiles from the green coal due to the lack of combustion air at a temperature high enough for combustion. It is possible that the economical solution might be the installation of a caustic scrubbing system on the lines of the previous plant whereby the pollution of both smoke and noxious gas could be eliminated. The scrubbing liquor might be then taken up to a sufficiently high concentration in tar acids, sodium sulphide and thiosulphate as to be worth consideration as a saleable by-product, which should cover raw material, pumping and plant depreciation costs.

Alternatively gas works ammoniacal liquor may be used for scrubbing as in the Simon Carves process, thereby producing a saleable by-product as ammonium sulphate.

REFERENCES:

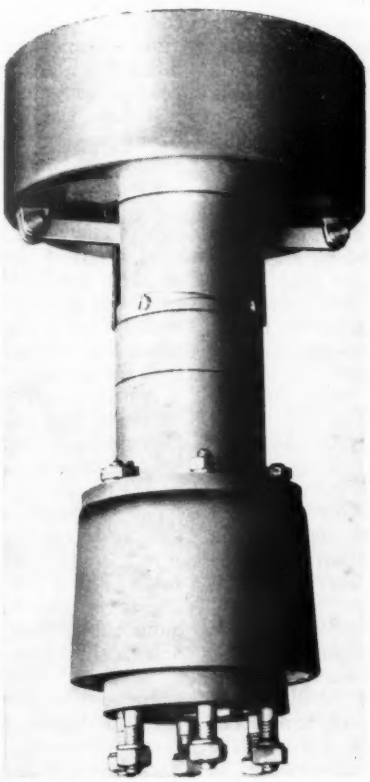
(1) Thring, M. W., Air Pollution. Butterworths Scientific Publications 1958.
(2) Air Pollution Abatement Manual. Manufacturing Chemists Association Incorp., Washington, D.C.
(3) Absorption Towers. G. A. Morris and J Jackson. Butterworths Scientific Publications.
(4) Chilton, T. H. and Colburn, A. P., *Ind. Eng. Chem.* 27. 255-60 (1935).
(5) Colburn, A. P., *Am.Inst.Chem.Engrs.*, 35. 311-36 (1931).
(6) Gilliland, E. R., and Sherwood, T. K., *Ind.Eng. Chem.* 26. 516-23 (1934).

Bulk Loading Control Valve

In conjunction with British Railways, Western Region, Zwicky Limited, Slough, Bucks., have developed a valve for preventing the overfilling of fuel tanks on diesel locomotives. On seven tests carried out with two valves in separate tanks, the tanks being run singly and together, the fuel metered into the tanks was in every case between 347·5 and 348 gal. an operating efficiency of 99%.

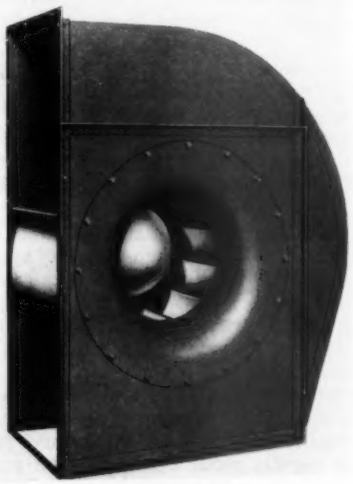
The valve is shown in the accompanying illustration where will be seen a float and linkage at the top and a flange at the bottom. The valve is mounted vertically on the top of the filler pipe which projects upwards through the bottom of the tank. The linkage controls a pair of spring operated pilot valves below which is a diaphragm and then the main valve.

When the tank is empty the float is down and the upper pilot valve is closed and the lower one open. The effect of this is to transfer fuelling pressure through the open pilot valve and to the underside of the diaphragm, thus lifting the main valve against spring pressure and allowing oil to enter the tank. When the tank is nearly full and the float is lifted by the rising oil, the upper pilot valve is closed and the lower one opened, thus relieving the pressure on the diaphragm to tank atmosphere and permitting the main valve to close under the influence of its spring, and shutting off fuel to the tank.



Zwicky "Full-stop" bulk loading control valve

In operation the valves open at a pressure of 4 psi. A single valve passes 64 gpm with an inlet pressure of 10 psi; two pass 40 gpm each with 6 psi, and four pass 22 gpm each with 4 psi.



Cyclone aerofoil fan

High Efficiency Centrifugal Fans

A new high efficiency aerofoil fan has recently been added to the range manufactured by Matthews and Yates Limited, Cyclone Works, Swinton, Manchester. A maximum total efficiency of over 90% is obtained by this design which is eminently suitable for air conditioning and ventilating installations with large volumes and high water gauges—particularly high velocity systems.

The impeller carries mild steel blades of aerofoil section welded to a steel back-plate and shroud-plate. The casing is built of welded steel plate and is braced with steel tees and angles, and incorporates a spun inlet cone. The casing may be for either left hand or right hand rotation and with any of the eight standard angles of discharge positions.

Ball or roller bearings are fitted to the cast-iron bearing pedestal or alternatively to the built-in bearing bridges secured complete with steel supporting legs to the fan sides. Driving is by V-rope or by direct coupling. The fans are made in a wide range with inlet sizes from 20 in. to 10 ft dia. Where extra large volumes are involved or where headroom is limited the double inlet, double width fan style is used in all sizes.

Sintered Metal Microfilters

Protection from contaminants in all classes of fluid transport is a subject which is receiving increasing attention. Closer tolerances, higher working pressures and velocities and the demand for extreme precision from hydraulic machines makes fluid filtering down to five microns or less an essential feature of system design. The performance of sintered metal filters has advanced appreciably within the past decade. This article describes current design and practice

DURING the past decade the standards required for industrial filtering have risen enormously. The aircraft industry, in particular, has been faced with an ever increasing problem of higher system pressures allied to closer working clearances in servomechanisms demanding positive protection against contaminant particles down to very small micron sizes. This is not only to eliminate the possibility of particles jamming small clearances spaces or clogging valves, etc., but to combat the fact that fluid velocities of up to 400 mph may be present in modern high pressure systems. At such velocities the presence of abrasive particles in the fluid can rapidly erode even hardened and polished surfaces adjacent to high velocity fluid streams.

In the general industrial fields, too, the advantages of fine filtering have become widely appreciated. On diesel engines particles of the order of 10 to 15 microns can definitely be injurious to injector pumps and nozzles and the general trend now is to specify that the filter cut-off should be brought down as low as 5 microns. The general standard of cleanliness required in engine lubricating oils is of the order of 10 to 20 microns cut-off, again influenced by the fact that working clearances on bearing and rubbing surfaces have tended to decrease. Machine tools, too, undoubtedly benefit from ultra-fine filtering whilst hydraulic systems, in particular, have undoubtedly tended towards higher pressures and smaller components, with resulting closer clearances.

Machine operators of all types have, in fact, been supplied with more and more 'precision' equipment over the past ten years or so, the benefits of which they have appreciated but their attitude towards use and maintenance has not necessarily kept pace with the technical advantages inherent in the machines themselves. In use the oil system, particularly a hydraulic system, is likely to be topped up with fluid dispensed from dirty cans—perhaps even with dirty fluid—on the basis that the system filter will "take care of that all right." More and more responsibility has thus fallen on the system designer, and the filter manufacturer, to provide as near as possible 'foolproof' protection as a strict necessity. But even he—at the present, at least—cannot provide for a clogged filter to be changed automatically, although he can provide indicating and warning devices controlled by differential pressure to indicate when a filter is in need of attention.

In any fluid circulating system with contaminants present, a high proportion of those contaminants can be considered as abrasive, accelerating wear and producing damage to rubbing surfaces. Apart from the fluid itself being dirty when introduced in the system, some contamination will be inevitable during working due to the formation of erosion products. This condition can be further exaggerated, and its effects accelerated, by continuing to circulate a fluid in a closed system beyond its rated 'life'. Oil fluids, for example, are stabilized against oxidation and deterioration with additives. Basically, these additives show a preferential attraction to factors promoting oxidation, but once used up they are effectively 'neutralized' and then the whole of the oil is subject to normal deterioration.

Other common sources of contamination are atmospheric dust, running-in wear products, scale from pipes, swarf or sand remaining in the crevices of castings and fittings after fabrication, fragments of sealing compound, scaled off paints and other 'protective' coatings, and the like. Filter cut-off size is not critical for removing the bulk of these, but probably a majority of the more abrasive—and thus potentially more harmful—contaminants will fall within the 10 to 20 micron size group. These, and smaller particles which may be passed can well have a cumulative effect.

Whilst the standard forms of filters with resin-impregnated paper, felt and similar porous elements continue to serve the bulk of industrial requirements, more and more interest is being shown in sintered metal filters for both fine and ultra-fine filtering. These have been investigated in a variety of types, geometry and materials yielding more or less standard production forms ranging from discs and plates to be assembled in a suitable housing to hollow cylinders and blind end cones, etc., forming a complete filter unit.

Of the various materials tried, sintered bronze has become the general standard, but other materials may be used. Ferrous metals are not now favoured on account of their corrodibility, although sintered stainless steel has been employed in specialized design cases. Cupronickel alloy is also a satisfactory choice under conditions which are corrosive to bronze and non-metallic (ceramic) type elements have also been investigated.

Another important factor is the actual geometric shape of the individual sintered particles forming the element. Compacts sintered from random, irregularly shaped particles do not give as satisfactory a performance as those compacted from closely graded spheres, even when fabricated with pore-forming agents. Although a similar degree of permeability may be realized the cut-off is not so positive and the effective filter life generally lower. The use of spherical particles, however, does limit choice of materials to those metals and alloys with sufficient surface tension in the molten state to form spherical shapes when atomized.

With spherical particles the porosity is directly influenced by the method of packing—see Table 1—the greatest degree of porosity being given with the cubic form where spheres are placed in square formation in each layer. It is also the least stable arrangement. The tightest form of packing—rhombohedral—increases the

unit density by $\sqrt{2}$ and almost halves the porosity. The quality of the filter can be assessed, to a large extent, by the relationship between effective pore size and permeability.

It is obvious, of course, that the theoretical geometry is appreciably modified by the act of sintering, when individual particles are welded together. The degree of sintering may also be varied as a means of achieving the required mechanical strength in the matrix. Logically, therefore, permeability will decrease proportionately to the shear strength achieved, the relationship being linear in the case of spherical components—see Fig. 1. Nevertheless, the basic uniformity of the filter matrix is maintained with known and controllable pore sizes so that a high degree of consistency can be anticipated with a positive cut-off. Random particle sintered metal filters are associated with the general limitation that cut-off is not specific and hence the rating is nominal, or can only be specified over a range. Also element 'migration' is more of a possibility.

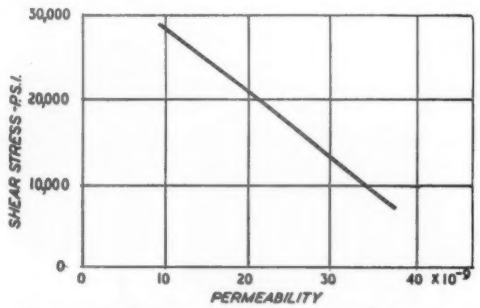


Fig. 1.—Sintered filter permeability as a function of shear stress

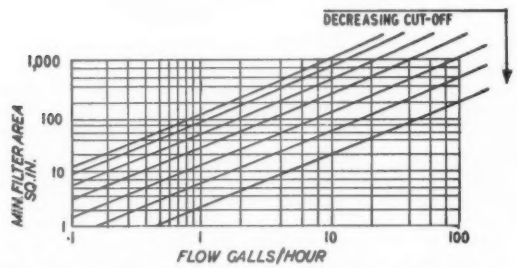


Fig. 2.—Typical method of rating sintered matrix, applicable only to standard or typical conditions

The extreme limit normally accepted for fine filtering is a cut-off at 4–5 microns, so that particles of greater than 5 microns in size are eliminated from the fluid system. This is normally adequate to eliminate all erosion problems and prevent silting of the normal precision servomechanism, etc., Where every close mechanical clearances are involved however, filtration down to 2 microns cut-off may be called for. Both these requirements can be met by current production sintered bronze filters.

The flow rating of a sintered metal filter must be based on the flow capacity of the complete assembly of filter element(s) and the element area necessary to pass an adequate volume of fluid to meet the system demand. Passages and valves would then be proportioned so that at maximum flow rate the least amount of energy is extracted from the fluid.

Mechanical strength will be related to system pressure, flow rate and fluid viscosity. Strength, as mentioned, can be increased by increasing the degree of sintering, and also by increasing the thickness of each element or shape. Line pressures up to 8,000 psi can quite readily be accommodated with standard productions and the

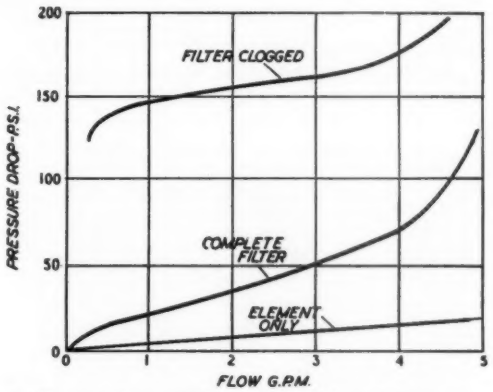


Fig. 3.—Diagrammatic presentation of complete filter performance

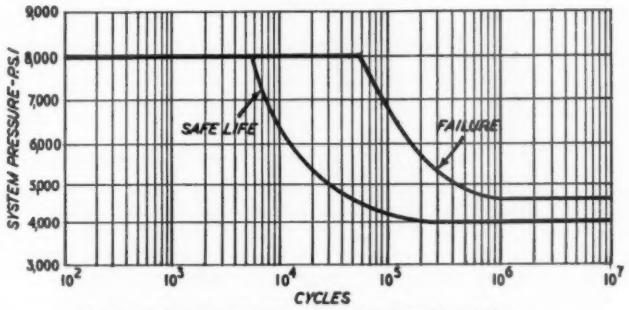


Fig. 4.—Fatigue characteristics of a typical sintered metal filter

element safeguarded by arranging for the by-pass valve to open well below the destruction pressure of the element in the event of clogging. A safety factor of at least four is usually allowed in such circumstances.

Performance data for sintered metal filters can be expressed in various ways. The individual particle size associated with a particular matrix form can be assessed on the basis of minimum filter area required for given flow rates—see Fig. 2. Such data, however, are only valid under nominal or specified conditions, although for average applications a choice can be made on this basis provided the Reynolds number of flow is consistent with the rated performance. For more critical applications the designer would consult with the filter manufacturer to arrive at a suitable size and form.

In the case of fully fabricated commercial filter units combining a suitable element array in a housing,

Table I.—PROPERTIES OF PACKING SYSTEMS

Method of Packing	Porosity %	Relative Density of unit cell	Theoretical Pure Area*
Cubic	47·6	1	0·215d²
Ortho-Rhomboid	39·5	1·15	—
Body Centred	32·0	1·3	—
Spheroidal	30·2	1·34	—
Rhombohedral	26·0	1·41	0·040d²

*d = particle diameter

individual units are normally rated on a flow rate basis for a stated maximum pressure and the filter characteristics expressed in the form of curves showing pressure drop against flow rates within the rated limit—see Fig. 3.

The pressure drop across a complete filter unit is due to a velocity head drop through the ports of the filter head (where applicable) and a viscous loss through the filter element itself. The latter are directly related to flow rate and viscosity in a new element. This linear relationship is useful in calculating the pressure drop of the element (new) for various fluids and flow rates, knowing the performance with a particular fluid of known viscosity and flow rate. From the latter data the coefficient K can be calculated for further working of the formula

pressure drop = KQV

where K = a constant (for new element)

Q = flow rate

V = fluid viscosity

The life of sintered metal filters is sometimes quoted as 'unlimited', since they are readily cleaned, but this is not strictly true. Apart from actual element 'migration' which may occur—although this can normally be obviated by correct by-pass setting to limit the pressure loading on the element—sintered metal filters are subject to fatigue effects. This is only noticeable when used in system pressures above the nominal maximum for the unit.

Typical fatigue characteristics of sintered metal filters are shown in Fig. 4, indicating safe life and failure limits plotted against cycles of operation from zero pressure up to maximum system pressure. In this particular example, the rated maximum pressure for the filter is 4000 psi, at which figure the safe life is indefinite. Used at high system pressures, a limit to safe life is indicated and, above about 4500 psi a limit to the number of work cycles which can be expected from the filter before actual mechanical failure takes place.

Even these limits, however, have little practical significance. Operating at 7000 psi, for example, the safe life of the filter is still of the order of 10,000 work cycles—consistent with many years of duty under normal operation.

The Dawe Type 1211 Strobopack transistorized, battery-operated stroboscope can be held in one hand. The 12V battery from which it is driven can be carried in a shoulder case

Battery-operated Stroboscope

The use of stroboscopes is spreading rapidly in industry. If the flash rate is adjusted until the illuminated rotating, vibrating, or reciprocating mechanism appears to be stationary, the flash rate equals the operating rate, which can thus be determined accurately. By allowing the flash rate to lag slightly, the mechanism can be observed in apparent slow motion and its dynamic behaviour studied without affecting it in any way.

The new transistorized Dawe Type 1211 Strobopack is completely portable since it can be powered by any 12 V d.c. source capable of supplying 1 amp. A battery pack is most convenient, but any battery of the correct voltage, such as that of a vehicle with a 12 V system, is equally suitable.

A pulse output is produced from the d.c. source by means of a multi-vibrator circuit, the repetition rate being controlled by a potentiometer through a slow-motion drive. After differentiation and amplification, the output from the multi-vibrator circuit is fed to a step-up transformer to provide the necessary high-votage pulse to trigger the flash tube. The neon-filled tube has a flash duration of 15 microseconds, so that sharp images are obtained to all speeds.

The output from the multi-vibrator also operates a frequency meter circuit, the 3·2 in. scale of the meter being calibrated directly in revalutions per minute. Flash rates between 600 and 15,000 per min are covered in two ranges, speeds higher than 15,000 rpm being measured by flashing only once in two or more revolutions. The accuracy is $\pm$ 2% of full-scale deflexion.

The new Strobopack measures $5\frac{1}{4} \times 3\frac{1}{2} \times 7\frac{5}{8}$ in. and weighs $3\frac{3}{4}$ lb. The 12 V battery weighs $9\frac{3}{4}$ lb and measures $9\frac{1}{2} \times 5\frac{1}{2} \times$ 4in. The transistorized circuits enable one battery charge to power the stroboscope for eight hours of continuous operation. The manufacturers, are Dawe Instruments Limited, 99 Uxbridge Road, London W5.

Diesel Lubricant

A special lubricant for diesel engines known as "Compre 107 Series" is being produced by Comprehensive Lubricants, 11 Iron Gate, Derby. The lubricant is claimed to reduce wear, to retain products of oxidation in clear solution and to have exceptionally long life.

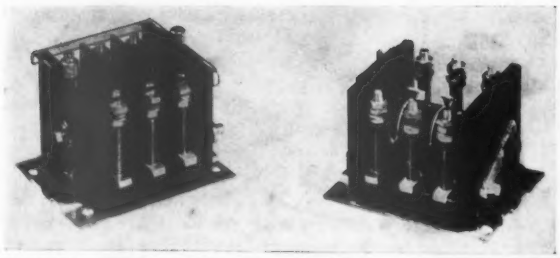


Fig. 1.—New type SA G.E.C. auxiliary switch. The protective cover has been removed in right-hand view

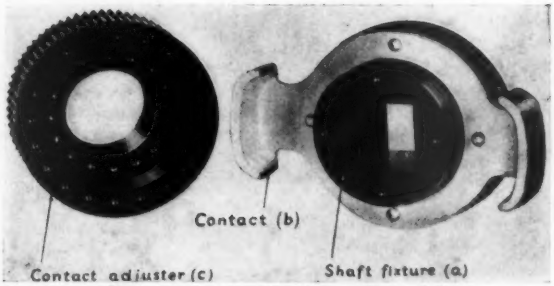


Fig. 2.—Contact assembly of new auxiliary switch

New G.E.C. Auxiliary Switch

The General Electric Company Limited has introduced a new auxiliary switch of advanced design for linking mechanical movement with the associated electric control, protective, and alarm circuits.

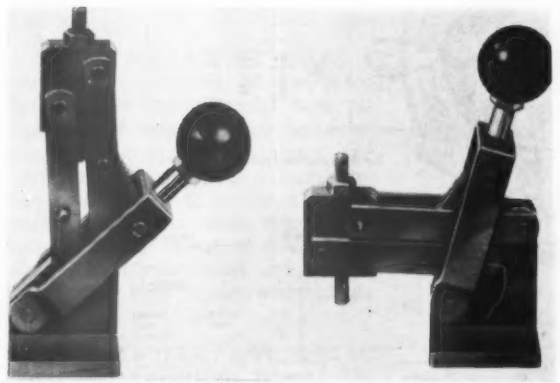
This switch, designated Type SA, is of unit construction and composite assemblies for controlling up to twelve circuits can be built up. The contacts are silver plated with a rating of 30 amp and are suitable for breaking d.c. inductive currents of 18 and 25 amp at 240 and 110 volts respectively.

Adjustments can be made to the angular position of each moving contact relative to the operating shaft by means of a simple vernier adjusting mechanism which forms an integral part of each moving contact assembly. This arrangement enables individual contact assemblies to be pre-set in any one of 21 effective positions, for a shaft rotation of 90°, for timing the making and/or breaking of the individual auxiliary circuits.

Each contact assembly consists of three parts, the shaft fixture, the contacts, and the contact adjuster. The shaft fixture (Fig. 2a) and the contact (Fig. 2b) each have four equally-spaced detents which engage respectively with an inner and outer circle of indents in the knurled contact adjuster (Fig. 2c). The inner circle has 16 indents evenly spaced 22½° apart, and the outer circle 20 indents evenly spaced 18° apart.

By moving the contact adjuster and contact together one position, the contact is turned through 22½° relative to the shaft fixture. Then, securing the adjuster and rotating the contacts back one notch (i.e. 18°) results in a net change of 4½° in contact position relative to the operating shaft.

A spring is provided to prevent the contacts moving out of engagement involuntarily during adjustment, while a clamping screw at the end of the shaft firmly locks the moving contacts once they have been set in the required position.



PARALLEL ACTION CLAMP.—A new clamp in the range of "Speetogs" made by Speed Tools Limited, Vereker House, Grease Street, London W1, has an up and down movement of the spindle instead of travelling in an arc. At the small final clamping movement this makes it possible for the clamping spindle to enter a locating hole on the component without fouling the edges or moving it. Another feature of the clamp is that it can be operated in a confined space

Pistol-grip Ratchet Screwdriver

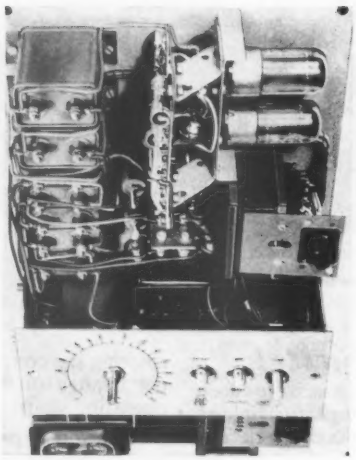
The oval-handled screwdriver has much to commend it for tightening or slackening a screw because of the extra leverage of the bulge of the handle within the palm of the hand. If there is any disadvantage it is only that the screw slot may not always result in the screwdriver handle being in the most convenient position. This is overcome in a new screwdriver introduced by J. Stead & Co. Limited, Manor Works, Cricket Inn Road, Sheffield 2, which combines a pistol grip handle with a ratchet mechanism. The combination enables the handle always to be held comfortably in the most effective position. The handle is of transparent amber plastic and the 6 in. blade is chromium plated.

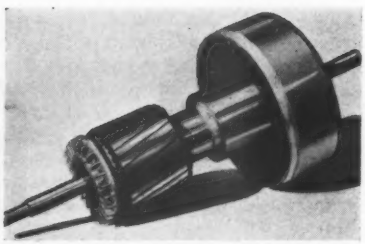
Sound-deadening Material

A new material for sound-deadening light gauge sheet metal has been evolved by Supra Chemicals & Paints Limited, Hainge Road, Tividale, Tipton, Staffs. The new material, "Dedshete", is manufactured in flat sheet and is self-adhering, and therefore requires no pre-fixing or taping in position. It is placed on the metal and stoved for 5 min at 300°F during which time it moulds itself and adheres to any contour. Adhesion is permanent, and it can be restoved at temperatures up to 350°F without adverse effect. No prior degreasing of the metal is necessary. Dedshete can be supplied cut to any size or shape within the limits of 42 in × 30 in thus ensuring that any defined area is covered to a uniform thickness.

£25 Single-phase Welder

Latest addition to the Weldcraft range of equipment is the Lion arc welder which operates from a normal domestic mains supply and features oil cooling for stable operation. This enables the set to be used continually on full industrial production for iron or steel welding. There are 15 current selections with an electrode range from 18 s.w.g. to 10 s.w.g. Welding rating is 5·5 kVA. The Lion measures 1 ft 2 in × 1 ft, weighs 1 cwt and costs £25 ex works. It is made by Weldcraft Limited, Windsor Works, Slough.



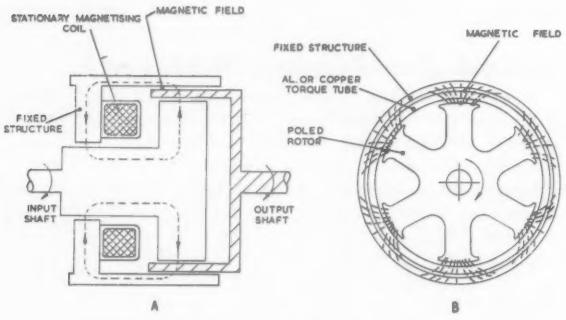


Exterior and interior of TASCmaster control unit and (right) armature and casing of motor/coupling unit

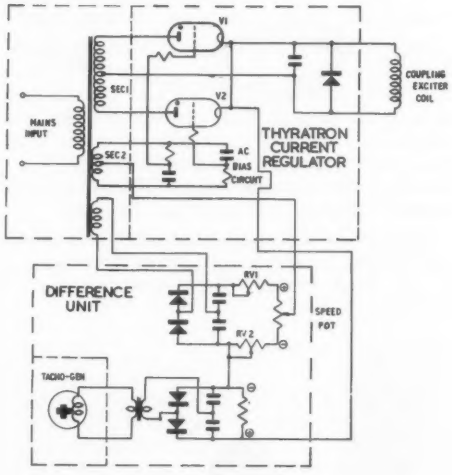
Speed and Torque Control of A.C. Motors

A radically new approach to a.c. motor control has been introduced by Pye Electric Limited, Lowestoft, in the form of TASC, which stands for "torque and speed control", a device which combines the advantages of precision, speed and torque regulation over a wide range with cheapness and durability.

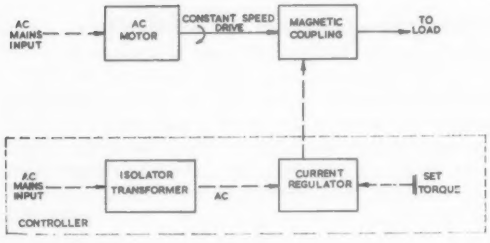
Two years ago the company was given the assignment of devising a coupling with accuracy of control to within 3%, capable of cheap mass-production, having no slip rings or brushes and requiring no special machine tolerances. The last requirement forced a complete re-appraisal of the existing technique of using large out-of-balance magnetic forces across small air gaps, resulting in heavy machines supported on large bearings. Six months of intensive work by a small team led by Mr. Norman Bancroft produced the basic



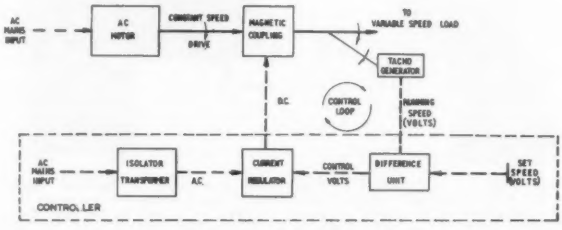
Basic construction of coupling



Basic thyratron control circuit



Coupling torque control basic block



Coupling speed control basic block

theory of the new device and production is now well advanced.

The TASC unit is an inherently constant torque device. It consists of two members rotating independently supported by a stationary fixed structure. A small air gap separates the members. The input member consists of an input shaft carrying a poled rotor. The rotor is surrounded by a torque tube which, mounted on the output shaft, forms the output member. The fixed structure consists of the casing ring which surrounds the torque tube at one end and at the other carries the exciter coil which is fixed to eliminate the need for slip rings.

The input member is driven at a constant speed from a source of rotary power. When the exciter coil is energized from a d.c. supply a steady magnetic field, which rotates with the poles of the rotor, is set up. This induces electrical currents and thus a magnetic field in the torque tube. The two fields interact to produce a torque in the torque tube which tends to drive it in the same direction as the poled rotor. The magnitude of this induced torque is directly proportional to the value of the exciter coil current and is thus easily controllable.

High Speed Rotary I.C. Engine

The development of the Wankel rotary engine, which commenced in 1951 when NSU began to collaborate with Felix Wankel, has been accelerated in the past 12 months by the Curtis-Wright Corporation of America who have produced high-capacity versions which will shortly go into production for use in aircraft and boats.

In the NSU-Wankel engine a somewhat triangularly shaped rotor turns in an epitrochoidal bore its centre performing a circular orbit round the output shaft centre, the orbit being correctly maintained by the eccentric rotor bearings in the casing. Since the rotor revolves at only $\frac{1}{3}$ of the speed of the output shaft, the inertia forces and surface speeds are kept within manageable limits.

The cycle is readily appreciated by going three times round the accompanying four diagrams, using the figures from 1 to 12 as a guide. Thus at (1) Fig. 1, the space between the upper lobe of the rotor and the bore is at minimum volume. As the rotor turns clockwise the space increases progressively, (2) Fig. 2, (3) Fig. 3, (4) Fig. 4, drawing in gas through the inlet port at top (arrow with white dots), and then decreases, compressing the gas, (5) Fig. 1 and (6) Fig. 2, until at (7) Fig. 3 compression is at a maximum and ignition occurs. Power is then developed at (8) Fig. 4, (9) Fig. 1 and (10) Fig. 2 after which exhaust takes place at (11) Fig. 3 and (12) Fig. 4. In the varying volume between each lobe of the rotor and the bore during one revolution there takes place induction, compression, expansion and exhaust—all features of the four-stroke engine.

Since there are three lobes on the rotor there are three power "strokes" for each revolution of the rotor. As might be imagined, therefore, the power output is remarkably high in relation to the physical size of the engine—in fact an engine of 125 cc developed 29 bhp at 17,000 rpm, and with a petrol consumption comparable to that of a 125 cc reciprocating piston engine. The very high speed suggests that application will depend upon the development of suitable transmissions.

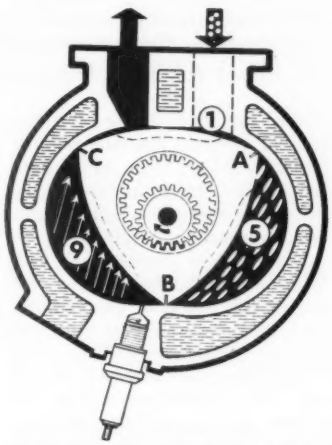


Fig. 1.—(1) Completion of exhaust and beginning of suction
(5) Compression
(9) Combustion

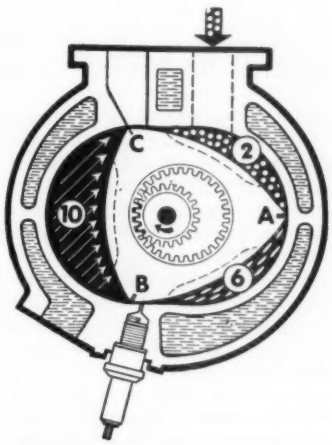


Fig. 2.—(2) Suction
(6) Compression
(10) Combustion

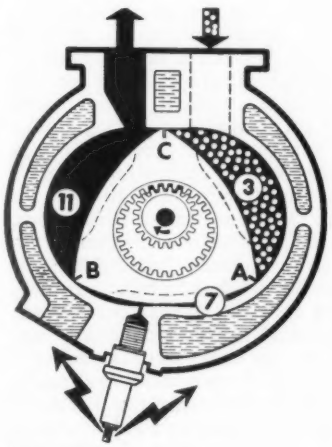


Fig. 3.—(3) Suction
(7) Compression and ignition
(11) Exhaust

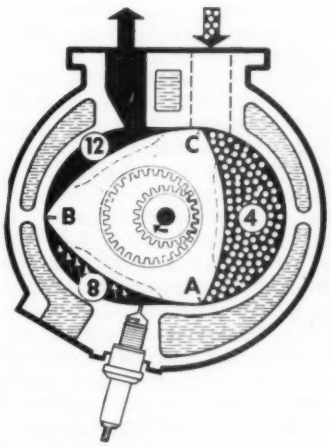
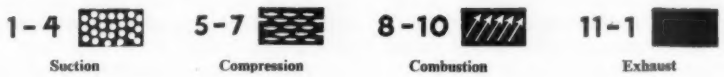


Fig. 4.—(4) Suction
(8) Combustion
(12) Exhaust



Centrifugal Casting of Low Melting Point Alloys in Rubber Moulds

The casting of lead- and tin-alloys in flexible moulds was introduced in the United States nearly twenty years ago, primarily for the production of costume jewellery. This still remains the major field of application, but recently the process has been adopted for the production of business machine components, parts for mechanical drives and other engineering applications where the strength and rigidity of these alloys is adequate and their other properties—high inertia, corrosion resistance and so on—are functionally valuable. It has been found that the process permits the holding of surprisingly close limits and, tool costs being low compared with other casting processes of equivalent precision, rubber mould casting may be expected to find increasing application for components not primarily requiring high strength, but calling for a high degree of dimensional invariance

By L. C. BARTON

THE casting of metal in rubber moulds was originally introduced to meet the specific requirements of the costume jewellery trade, which still makes widest use of the process. Of recent years, nevertheless, there has been an increasing use of rubber moulds for the production of strictly functional components, where these can satisfactorily be produced in an alloy melting at 300°C or less. Although on a tonnage basis the importance of such pieces to the foundry industry is perhaps not great, it is evidence that the rubber mould technique offers, within its admittedly limited scope, some very real and unique advantages. The most outstanding is, unquestionably, the incredibly low tool costs which the individual casting has to carry.

Individual mould sets can be produced for fifty or sixty shillings, and the master patterns to produce them—if indeed these are required—need cost no more than £12 to £15. On work of simple form, each mould has an effective life of two to three thousand casts, and since multi-impression moulds are virtually standard, producing a spray, or "spider", of six to ten castings, the throughput of a single mould set during its working life can run from twelve to thirty thousand unit castings. Amortization of both pattern and mould costs over one such run adds only a fraction of a penny to the cost of each component, but the master pattern lasts indefinitely and, if requirements warrant it, can produce any number whatever of replacement mould sets.

Functionally, perhaps the most notable feature of the process is that, the moulds being flexible, minor undercuts do not rule out the practicability of a design as they do in the related techniques of die-casting and permanent-mould casting. This is well exemplified by a worm-gear with a two-start thread, which is cast in a rubber mould with the axis in the plane of the parting. Whilst parts of this general form can certainly be diecast, they have to be cast with the axis normal to the parting. This entails unscrewing the piece from the die, and also imposes restrictions upon the detailed form of the thread.

The ease with which fine detail can be reproduced from rubber moulds is well recognized, and is of course fundamental to the use of the process in the manufacture of costume jewellery. It is not always recognised, however, that rubber-mould castings can be held without especial difficulty to normal engineering limits. For example, parts of a business machine cast in rubber moulds have been consistently held to plus or minus 0·005 in. on all dimensions. This is admittedly exceptional, but primarily so only because the demand for such accuracy has only begun to arise during recent years. Essentially, rubber moulds are capable of the same dimensional precision and invariance as metal moulds. In fact, since the formation of the impressions and the moulding-in of the registration elements are one and the same process, there is not the same possibility of initial misregistration as exists, say, in a diecasting die; in the latter the two cavity portions are of necessity sunk separately.

Although the preparation of a pattern-plate, or match plate, can be dispensed with when experimental or speculative moulds are being produced, this step is essential when it is expected that a series of identical moulds will be required. The match plate is a brass disc of the same size as the required mould—about 9 in. dia in usual practice. If the castings to be produced are flat-backed, the individual patterns are secured to one side of the plate. Patterns in low melting point alloys are pegged and screwed, the contour then being built up again with soft solder and refinished. Brass patterns, which are preferable for engineering quality castings, may be sweated to the plate with a tin solder.

If the shape of the part is such that the parting cannot lie along one face, the patterns are made in two halves and are dowelled together while in correct register. The dowels are long enough to allow the parts to be reassembled on each side of the match plate and secured as before; the holes in the plate are very much larger than the dowels (Fig. 1) to allow for positional adjustment. Registration of the two rubber mould halves is effected by drilling four equally spaced holes through both discs, using a tubular drill and locating by means of a cruciform jig-plate which is standard for all moulds. Conforming to the hole centres are recesses in one side of the match plate; these accept the heads of studs inserted in one of the rubber discs (Fig. 3). Projecting buttons on the top of the match plate are identical in form and size with the stud heads.

In addition to the casting patterns and the registers, the match plate

is fitted with a central boss of 1–1½ in. dia, which may be either fixed or merely dropped over a central dowel. It is desirable also to fit the plate with kidney-shaped risers or "pressure cushions" (Fig. 2), and these are sometimes connected with the central boss by runner rods. However, both risers and runners are often omitted from the match plate and are cut into the mould afterwards. If the risers are to be moulded they are, as a rule, fitted to one side only of the match plate. In order to avoid too great a stress during curing, the outer face of the appropriate disc is shallowly cut away to allow easy deformation of the mating face. The rubber is similarly thinned down above any heavy parts of the actual patterns.

Production of the moulds is by simple vulcanization equipment; the match plate is sandwiched between the two prepared rubber discs and a retaining ring placed around the assembly. The mould set is then slowly compressed between heated platens (Fig. 3) until the inner faces of the discs conform exactly to the match plate contours. The rate of compression is a matter of judgment, but is generally completed in two to three minutes. Thereafter, the mould set remains under full pressure while vulcanization is completed. For discs of ⅜ in. unit thickness, curing takes less than an hour.

Many variants on the match plate methods have at one time or other been tried out: these include the use of a composite match plate with interior resistance heaters (conventional match plates have to be preheated), and separable paired match plates which are mounted with their plain sides in contact with the heated platen to produce each half mould separately or—with a plain disc interposed—to produce two halves at the same time but back to back. Apart from these modifications, however, there are more radical variants of mould-making technique which eliminate the match plate altogether.

None of these, of course, is able to produce a series of absolutely identical mould sets, but this is not in practice a serious disqualification. The method giving the best finish, and a near approach to standardization, is the use of permanent patterns consisting of the central pouring-hole boss with radial runners and terminal pressure cushions attached. To this basic assembly—chosen to have a suitable runner length and

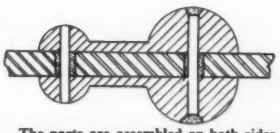


Fig. 1.—The parts are assembled on both sides of the match plate, the dowels being in a solder filling in the plate and on the ends (at right) and filed smooth (at left)

cushion volume—the individual casting patterns are attached by short lengths of ductile solder wire. This allows the patterns to float, and when the mould discs are pressed together adjustment to the natural parting (which may be non-planar) takes place automatically.

The simplest method, widely used in the novelty trade for speculative designs, is essentially similar to the "oddside" moulding practised in

Fig. 2.—The plate has kidney shaped risers or "pressure cushions" between runner and gate leading to cavity

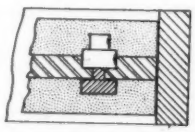


Fig. 3.—Register studs. The chase is in section (at right)

brassfoundries. In this, a thick-walled tray is filled with a pasty plaster mix and, before this sets, the individual patterns are partly embedded in the surface. Pouring-hole boss and runner rods are placed in position (the latter are sometimes omitted) and the plaster allowed to set. The surface is now scraped over to smooth, not level it, and excess plaster is carefully cut away from the edge of the casting patterns to follow the required parting.

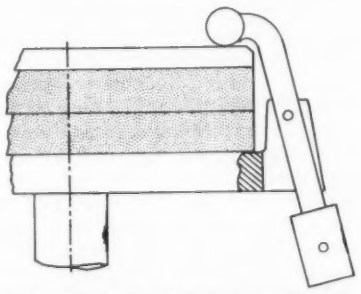


Fig. 4.—The swinging clamping arm pivoted to the rotating table is weighted at the bottom and, in motion, exerts downwards pressure on the top plate

A rubber disc of standard size is now taken and drilled through at three or four points near the edge, chosen to miss the patterns. Sawn-off hexagon-headed bolts are inserted in the holes, the heads projecting from the working face. This is dusted with talc or zinc stearate. Holes are roughly cut in the plaster where the bolt heads come, and are filled with fresh plaster. The rubber disc is placed in position—a central hole fits over the pouring-hole boss—and the rubber-plaster assembly placed under the vulcanizing press. Pressure is applied slowly until the rubber and plaster are in contact all over; around the hexagon-head registers the joint surface adjusts itself to the unset plaster, the volume of which is thus not critical. While the assembly is being compressed, the punch is brought slowly up to temperature. Pressure is maintained during curing; as already noted, this takes from 45 to 60 mins if the rubber disc has been preheated.

After removal from the press the assembly is allowed to cool and the plaster is removed piecemeal; the patterns and other loose parts are left embedded in the rubber. The surface is carefully brushed to removed all plaster particles and dusted again with the parting agent or wiped over with glycerin. The other disc is placed in position and the two replaced under the press, uncured mould-half upwards. Slow pressure as the heat is coming up brings the softened upper disc into contact with the vulvanized disc and the embedded patterns over the whole pressure are, lateral spread being restrained by a circular chase as before.

Whatever the mode of producing the mould, the method of casting the components is virtually standardized. After any runner details that have not been moulded have been cut in the cured rubber, using standard rotary rubber rasps and a flexible shaft outfit, the assembled mould is placed on the turntable of a centrifugal casting machine and a steel top plate placed above it. When the turntable begins to rotate, pivoted weights are thrown outwards and the inner ends of their lever-like extensions (Fig. 4) press down upon the top plate, holding the mould halves tightly together. The cover of the machine, which is always placed in the closed position before rotating the mould, has a central pouring basin by way of which metal is led into the mould. The molten metal is flung along the radial runners and begins to fill the pressure cushions, whence it passes

by way of the thinner feeding runners to the cavities. With the mould rotating at 1,000 rpm—and much higher speeds are common—the pressure exerted by the heavier low-melting-point alloys near the periphery of the mould is fully comparable with injection pressure when diecasting similar alloys.

As soon as the cast is made, the motor is switched off and the machine slowed down. The mould is removed, the castings and spider stripped out, and the mould reassembled for the next cast. A mould dressing such as talc or a finely-divided silicate is often dusted on the joint faces before each cast. As it is critically important not to overheat the mould adjacent to heavy sections, such as the pressure cushions, it is advantageous to provide a set of air-blast nozzles by which the impressions can be cooled down between casts. Alternatively, and preferably, duplicate moulds can be operated so that each has time to cool. Because of the long time required for the mould to slow down, it is practicable for an operator to handle two castings machine: in the U.S. this is usual. Twenty-five to thirty casts per hour per machine is a good average production rate, casting twelve to fifteen ounces per shot in lead-base alloys. Although the moulds can be operated unmounted, they are easier to handle if backed by steel discs. A separate top plate is then not required. If the components have heavily undercut portions, however, it may be necessary to run them unmounted in order to obtain sufficient flexure for stripping.

An advantage of rubber-mould casting over diecasting is that, for any given alloy, the casting temperature can be appreciably lower since the chilling effect of the mould is much reduced. Thus, for example,

Table I.—LOW-MELTING-POINT ALLOYS FOR RUBBER MOULD CASTING

Composition %	Alloy No.				
	1	2	3	4	5
Tin	90–92	80–84	64–66	4–6	Nil
Antimony ...	4–5	12–14	14–16	14–16	9–11
Lead	0·35*	0·35*	17–19	79–81	89–91
Copper, max. ...	*max. 4–5	4–6	1·5–2·5	0·5	0·5
Mechanical Properties*	1	2	3	4	5
Tensile strength lb/in, ...	9 000	10 000	7 800	13 800	12 500
Impact strength Izod, ft lb ...	–	–	–	0·6	0·4
Elongation % on 2 in.	2	1	1·5	10·5	2
Brinell hardness...	24	30	28	23	24

* Properties given are contingent upon low impurity contents being maintained in all alloys. Major contaminants are aluminium, manganese, arsenic and zinc.

the melting point of one of the most-used tin-base alloys is about 240°C, but more than 200° of superheat is necessary for best results in die-casting—the casting temperature, that is, lies far above that of the zinc-base alloys which melt at 380°C but need only 25° of superheat.

A disadvantage is that, if the melt is held only a few degrees above melting point, there is a tendency toward segregation with the heavier phases of the often complex alloys separating at the bottom of the pot. This is best avoided by using only small pots and recharging them constantly with ingot. The castings produced should be clipped from the spiders immediately and the waste metal fed right back to the melting pot. A pair of tinman's snips with one arm clamped in a bench vice copes effectively with the softer alloys.

The number of extant compositions for low melting point alloys capable of being cast in flexible moulds is very great, but for practical purposes there seems little reason to use any but the three tin-base, and two lead-base, of which the composition and properties are given in Table I. These cover a good range of strength, hardness and—with their varying tin content—metal cost. Their specific gravity ranges from 7·3 to 10·7.

With so many clear advantages, it is not surprising that attempts have been made to extend the scope of rubber-mould casting. These have been in two directions; to use static flexible moulds instead of rotating ones, injecting metal under low pressure or by suction, and to cast the stronger—and more generally acceptable—zinc-base alloys by the centrifugal process. Although the first is marginally practicable, it does not appear to be possible to obtain the same sharp definition which the standard methods give. As to the second, which obviously depends upon the development of more heat-resistant flexible mould materials, it has remained so long "just around the corner" that even the most sanguine experimenters seem now to have jettisoned the idea. Nevertheless, a successful breakthough in this direction, possibly using filled rubbers of superior heat conductivity such as might be obtained by metal-fibre reinforcement, cannot be altogether excluded. Assessing such a prospect, one sees it less as a threat to the established diecasting industry than it might at first appear, for the mechanical strength of parts which have been cast from zinc-base alloys in this type of mould has been very low. Only the chilling effect of a steel die produces a satisfactorily fine-grained structure, and the concomitant high strength, in zinc-base alloys.

Solenoid-operated Stop Valve

A new solenoid-operated valve for installation in liquid-carrying pipelines has been introduced by Simmonds Aerocessories Limited, Treforest, Pontypridd, Glamorgan, a member of the Firth Cleveland Group. The purpose of the valve is to start or stop the flow of liquid in a pipeline by the establishment or failure of the electric supply current. The valve may be used as a remotely-controlled stop valve.

One important application is closure to keep a pipeline full of liquid in the event of current failure to the motor driving the pumps. The valve is available for operation from d.c. or a.c. supplies and in both flameproof and non-flameproof versions. It is normally manufactured from high-tensile aluminium alloy, though a forged steel version can also be supplied.

The valve comprises a standard Simmonds discharge valve and a solenoid operated pilot valve, the latter controlling a by-pass line across the main valve. When the current is switched on, the pilot valve opens and fluid can flow through the by-pass line across an orifice. The low-pressure side of the orifice is in communication with the main valve cover which is separated by a diaphragm from the main fluid inlet. The resulting pressure difference across the diaphragm is used to open the main spring-loaded plug valve.

If the electric current should fail, the pilot valve closes, cutting off the fluid flow through the by-pass line and thereby destroying the pressure drop across the orifice. The pressure across the diaphragm therefore equalizes, and the plug valve closes under spring action, shutting off flow through the main pipeline.

This method can be reversed in that the pilot valve can be arranged to open on the failure of the electric current. In this case, the main valve is held closed by the establishment of the current.

New Voltage Controlled Overcurrent Relay

An overcurrent relay designed to protect alternators against both overload and short circuits has been introduced by the Meter, Relay and Instrument Division of the English Electric Company Limited.

When used for main or back-up protection of alternators, overcurrent relays have often to meet the conflicting requirements of giving adequate fault settings on loads close to full load and giving normal overload protection. This is because the sustained short circuit current on external faults may be limited to a value below full load.

For full protection against overload and short circuit conditions measurement of current alone is insufficient. This new relay also measures the terminal voltage. Called the CDV22, it is basically the type CDG standard inverse time-overcurrent relay equipped with a voltage sensitive element which permits it to discriminate between overload and short circuit conditions.

To take advantage of the thermal capacity of most alternators the operating time under overload conditions is longer than the corresponding time provided on a standard inverse time-overcurrent relay. Under short circuit conditions a fast operating time is provided. This form of protection can be applied to solidly or resistance earthed alternators.

New Regulator for Central Heating

An entirely new conception in central heating regulators has been introduced by Hattersley (Ormskirk) Limited. The new fitting, covered by Prov. Patent No. 29881/59, is both efficient and good looking, much attention having been paid to the need for a design which will harmonize with any modern decor.

The handwheel and stem of the conventional valve have been dispensed with, for the new regulator incorporates a sleeve which rotates in the cast gun metal body. Movement of the sleeve is controlled by a neat ivory-coloured head incorporating a complementary grey indicator plate. Like the heat control of an electric cooker, the regulator is instantly adjustable by fingertip pressure. The sleeve design ensures that the regulator can be fully

The new Hattersley regulator for central heating equipment

closed with no more than the light pressure necessary to obtain the desired setting.

An important feature of this new regulator is that a glance at the control head pointer will show for what proportion of heat output the radiator is set. As is well known, the heat output of a radiator is not in direct proportion to the rate of water flowing through it. Hattersley engineers have devised a simple scale for the control head indicator which gives exact settings, from fully open to shut, for $\frac{1}{4}$, $\frac{1}{2}$ and $\frac{3}{4}$ of the radiator potential, whereas with a conventional valve, obtaining the correct setting can only be a matter of experiment. This Hattersley regulator is available in $\frac{1}{2}$ in. size in both angle and straight patterns and a lockshield type is also available.

Stainless steel rotor type pump

Zero Gland Leakage Pump

A zero leakage pump specially designed for operation where the nature of the liquid pumped demands there be no leakage whatsoever has been introduced by Sigmund Pumps Limited, Team Valley, Gateshead 11.

Constructed in stainless steel the pump is of the canned rotor type completely eliminating glands, mechanical seals and similar sources of leakage. The bearings are lubricated entirely by the pumped liquid and no contamination by oil or grease is therefore possible. For this same reason maintenance is reduced to a minimum.

The rotating element, mounted on a fixed stationary axle, is hydraulically and dynamically balanced to ensure smooth operation. In consequence there is no thrust bearing and the life of the rotating parts is considerably extended. The end cover is easily removed to give access to the rotating element, which can be withdrawn without breaking the pipeline joints and without interference with electrical connexions. The squirrel cage rotor is shrouded by stainless steel, and the totally enclosed stator is suitable in the standard design, for pumping temperatures up to 260 °F. Special windings are available to permit pumping temperatures from sub-zero to 400° F.

The unit is designed for foot mounting, in many instances however, direct pipeline mounting is permissible provided the axle is kept in the horizontal plane. The branch size is $\frac{1}{2}$ in., output is up to 8 gpm, and head up to 60 ft.

Bench Muffle Furnace

A new bench model, all-purpose, muffle furnace has been designed by the Allied Engineering Division of Ferro Enamels Limited, Wombourn, Wolverhampton, to meet the demand for a neat, compact and reliable unit for temperatures up to 1000° C. The working chamber consists of a nichrome wound muffle forming an independent unit readily interchangeable with the minimum of effort. The muffle size which has proved to be most practicable for test firing samples is 18 in. deep by $5\frac{1}{4}$ in. high by $7\frac{1}{2}$ in. wide.

A guillotine-type door operating on a chain and pinion mechanism and counterbalanced is provided. Control is effected by an infinitely variable energy regulator operating through a contactor relay. The furnace is also available with fully automatic control.

Signal lights indicate electric supply to the kiln and position of contactor. A safety switch breaks the supply when the door is opened. The furnace operates off standard single-phase supplies, is normally rated at 2·75 at 230 volts and reaches 800° C in one hour. Temperature uniformity is ±5° from the front to the back of the muffle.

Registration Control for Packaging Machinery

A new Elcontrol registration controller has a new scanning head, using a minute photocell, which is much smaller than anything previously available. Its overall dimensions are only 4½ in. × 2¾ in. × 1⅝ in. It produces a correspondingly very small light spot. The scanner can therefore be used in modern packing and wrapping machines where space is limited, and it will give increased accuracy and closeness of control.

A new one-way control unit and the two-way control unit embody a photo-electric gating circuit for controlling the operation of the appropriate correcting relay circuit which does away with the necessity for external contacts operated by a cam switch. The installation of an automatic correction system is thus greatly simplified and is correspondingly less expensive.

The usual application for this type of registration controller is in packing, wrapping and folding machines where it is necessary to synchronize a rotary knife or other operating mechanism with a printed pattern or mark, and to do this with the highest possible accuracy at maximum operating speeds. Other specialized applications also arise from time to time and we are always glad to advise on any control systems where photo-electric equipment may be suitable.

Registration with the one way unit requires either a registration mark or part of the printed pattern to be scanned photo-electrically, and a correction mechanism to be fitted to the machine, capable of retarding the position of the knife with respect to the strip feed. The feed of the strip is arranged to underfeed by a fixed amount, and when the predetermined distance of out-of-synchronism is reached, the knife-retarding mechanism will be operated, bringing the set-up back into synchronization.

For two way correction a registration mark or selected portion of the printed pattern can be used, and the knife mechanism (or the wrapper feed) must be capable of being corrected in either direction while running. When the strip is running in correct synchronization, no correction will be applied, but when it drifts out of synchronism either way the appropriate correction will be applied for a length of time determined by the setting of the correction timer in the control unit.

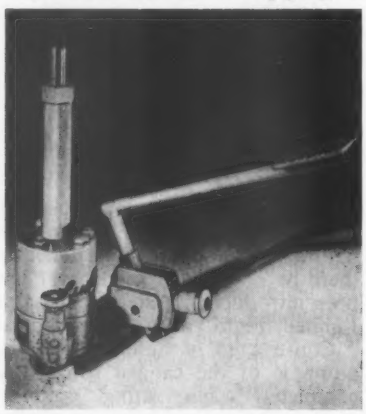
Both units have provision for connection to two pairs of viewing heads and light sources, quite apart from the scanner. These are used to monitor a disc having a cut-out segment and driven by the guillotine shaft. When the disc is in such a position that no light passes through the cut-out segment, the control unit will not accept the signal from the scanner arising from the passage of the registration mark. When the segment is sufficiently out of registration, however, the correcting signal is accepted and the correction mechanism operates in the required direction. (Elcontial Limited, 10 Wyndham Place, London W1.)

Pump-ram Unit

At the request of users in the mechanical handling field, the Linford Model 4000 hydraulic, combined pump-ram unit has now been developed for foot operation. This development has been made to cater for equipment which, for design considerations, is more suitable for foot rather than hand operation. The unit is now particularly suitable for incorporation into lifting tables, elevating conveyors, mobile and static stacking equipment.

Due to the necessity for spring return of the foot lever, this new version is single acting in the pump operation but the arrangement is such that the oil displacement is equivalent to the double acting hand operated units and results in no sacrifice in rate of lift.

Available in five capacities, 1100, 1600, 2200, 3300 and 4400 lb, this combined unit is compact and easy to instal as no piping is required. The unit is designed and manufactured by the Linford Engineering Company Limited, Baker Street, Birmingham 11.



Foot-operated version of the Linford hydraulic combined pump-ram unit

This new 10HV relief valve, introduced by The Plessey Company Limited at this year's Smithfield Show, has a flat characteristic over a wide flow range

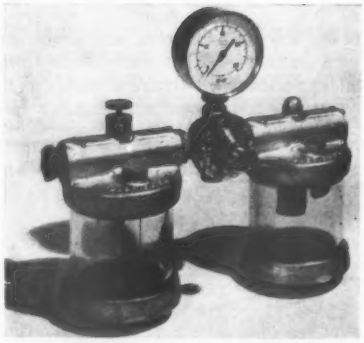
Flat Characteristic Relief Valve

A new relief valve, the 10HV, has been designed by the Industrial Hydraulics Division of The Plessey Company Limited, Ilford, Essex, and is now in production. With a working temperature of 0—100° C, the valve is compact and stable, pilot-operated and capable of accepting flows of up to 10 gpm with a pressure range of from 100 to 3,000 psi. An outstanding feature of the new valve is its flat characteristic over a wide flow range.

Connectors and Servo-motors

Of interest to engineers in the electronic field and to industry generally are the small size BNC connectors and adaptors developed by Smiths Aviation Division, Wembley. They are lightweight, weatherproof, quick to connect and disconnect. Insulation is P.T.F.E. throughout the range, which covers straight-through, right-angle and T-connectors, with panel, cable or bulkhead mountings. The maximum current is one ampere; maximum voltage 500V peak, and nominal impedance 50 ohms. Single-hand operation facilitates their use in awkward locations and their positive locking action ensures vibration-proof connection.

The company now also make a very wide choice of synchros, which includes over twenty different types. In addition, an entirely new range (BCS) of high-temperature, Grade 1 synchros will shortly be available. The range falls into three main types: hysteresis motors, dragcup motors and induction motors. The size 07 induction motor is the smallest unit of its kind in production in Britain.



The new Wakefield oil mist spray equipment for feeding coolant spray to the work face

Coolant Mist Spray Equipment

A unit which enables soluble or neat coolants to be fed to the work face in circumstances where surface speed normally makes dry machining necessary has been introduced by Wakefield-Dick Industrial Oils Limited. It functions by delivering a fine mist of coolant in a stream of compressed air.

The unit, Model M3892, operates at 10–20 psi and consists of three major components; a porous bronze filter element, a pressure-reducing valve complete with gauge to indicate the reduced air pressure, and an Ayrlyne lubricator with flow adjustment.

The lubricator embodies a ½ or 1 pint transparent oil reservoir with needle regulating valve controlling the oil flow. The ratio of oil to air can be adjusted by a regulating screw at the top of the lubricator.

The unit is suitable for use with neat cutting oils of a viscosity not exceeding 300 Redwood seconds at 70° F or with soluble oil emulsions. The prices are ½ pint £12 11s. 3d. and 1 pint £13 12s. 3d.

Heat and Vapour Seal for Hot Processing Baths

A new treatment which provides a protective chemical blanket for hot immersion processing and which results in greatly reduced heating costs, improved working conditions and a reduction in equipment maintenance, has been introduced by the Metal Finishing Division of The Pyrene Company Limited, Brentford, Middlesex. The 'Heat-Lok' treatment, as it is called, consists of two integral components, namely the Heat-Lok sealant, forming a protective blanket on the surface of the processing bath, and the Heat-Lok additive which is a surface activating agent in the processing solution itself. The additive is replenished in direct proportions to the amount of replenishing chemical used for maintaining the specified concentration of the processing solution. The sealant is added as required to maintain approximately ½ in. thickness of chemical blanket on the surface of the solution.

New Vibratory Conveyor

A new type of vibratory conveyor has been developed by Sinex Engineering Company Limited, of North Feltham Trading Estate, Feltham, Middlesex. It has a fixed rate of feed, few moving parts, requires little maintenance and is

The new conveyor has a feed trough fitted with a pair of Sinex electric vibrators

silent in operation. It is particularly adaptable where very little headroom is available and applications for which it is specially suited are those involving the simple transfer of material from one point to another; the feed can be stopped or started at will and although the speed of travel remains constant the level of material can be altered by means of a gate to control the amount being fed.

The conveyor, the length of which is adapted to requirements, comprises a feed trough fitted with a pair of the new standard SV range of Sinex electrical vibrators, one on each side of the trough. The vibrators are mounted with their shafts in a vertical plane but inclined at a specific angle to provide a feed of material in one direction along the trough. Each conveyor can be supplied complete with base structure or with simple mountings for attachment to the customer's equipment. The only moving parts are the rotors of the vibrators. Vibrators can be quickly replaced if this eventually becomes necessary, by virtue of their 4-bolt lug mountings.

Saw with Progressive Teeth

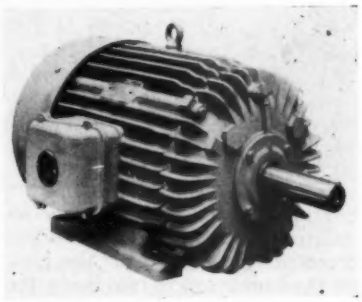
One of the most common causes of trouble with hand hacksaw blades is failure to select the correct pitch of teeth for a particular job. This often causes breakages of teeth or of the blade, particularly if high-speed hand blades are being used. Blades having teeth of four different pitches have to be kept in stock if all kinds of jobs are to be handled without trouble. These range from 14 teeth per inch for cast-iron to 32 teeth per inch for tubing and sheet.

A new hacksaw blade with progressive teeth which overcomes the necessity for changing blades for different jobs is being manufactured by Hacksaws Limited of Sheffield. Called the "Aven", it has a pitch of 29 teeth per inch at the start, increasing in size gradually to 18 teeth per inch at the back end of the blade. One effect is to cause the amount of material removed to be increased as the stroke progresses and increased weight is applied.

The blades are made in both high-speed and low tungsten steel.

New A.E.I. Motor

An addition to their range of industrial motors has been made by the Motor and Control Gear Division of Associated Electrical Industries Limited. The new motor is designated Type KN-D and is of the squirrel-cage induction class, totally enclosed fan-cooled, with ribbed frame and endshields. Class-E insulation is used, permitting a maximum temperature rise of 65° C. The machine



New AEI motor

complies electrically with BS 2613: 1957 and its dimensions are such that it is completely interchangeable, rating for rating, with the ventilated (AEI Type KN-C) British Standard Dimension motor built in accordance with BS 2960:1958.

The use of the improved insulation makes it possible to offer a motor of smaller dimensions at a lower price than the earlier Class-A insulated 55° C rise British Standard Dimension machine which it replaces.

The new motor is available in sizes up to 7½ hp but at a later date the range will be extended to 40 hp at 1500 rpm.

technique

—devoted to the discussion of practical problems
Readers are invited to contribute items from their own experience in matters relating to design, manufacture and maintenance

Finishing the Rims of Numbered Wheels

Small numbered wheels are now being required in greatly increased numbers for instruments for industrial counting, digital recording, ratchet and revolution counters and similar instruments. These are black moulded plastic discs about $\frac{5}{8}$ in. dia, having the figures 0 to 9 deeply formed round the diameter (Fig. 1). The depressions have to be filled in with white paint for clarity and for this purpose, the entire surface of the rim is first sprayed with paint, and the paint then removed from the rim so as to leave the figures showing clearly in colour.

A new method of approach to this problem has been evolved by Arthur Scrivener, Limited, Tyburn Road, Birmingham. They employ as a basis their smallest size of centreless grinder, the Wickman-Scrivener No. 0, having in this instance a grinding wheel 12 in. dia by 2 in wide and a control wheel 7 in. dia by $1\frac{1}{2}$ in. wide, the former running at 1,800 rpm. A carrier feed (Fig. 2) has a series of pins on both sides of the carrier ring on which the pieces are mounted. The method employed can be followed from Fig. 4 which shows in exaggerated form the carrier ring which envelops the control wheel. Carrier ring and control wheel are mounted slightly eccentric, the loading of the pieces on the double row of pins being done by the operator at the side of the ring farthest away from the grinding wheel at a point where, owing to the eccentricity of the carrier ring and control wheel, pieces can be freely loaded. The carrier ring, driven by an independent motor, carries the pieces round to the grinding position approximately level with the axis of the grinding wheel, at which point it also contacts and is controlled by the control wheel while being ground. The ground pieces remain on the carrier ring until they reach a point approximately one-third of a revolution from the grinding position, where each pair of ground pieces is ejected into a chute by means of a blast of compressed air.

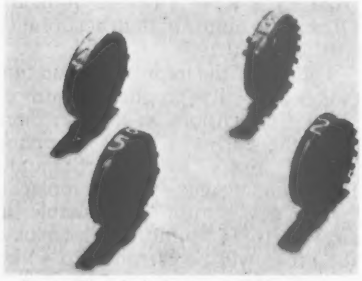


Fig.1.—Typical wheels, ground and unground

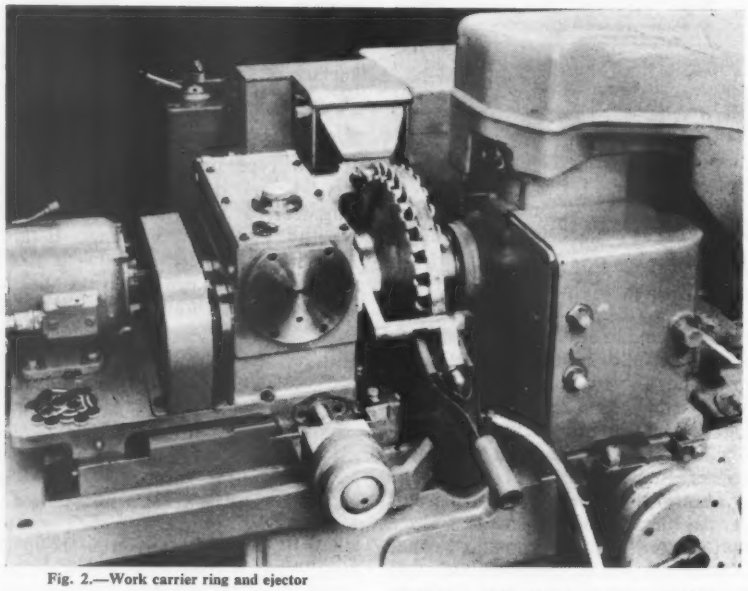


Fig. 2.—Work carrier ring and ejector

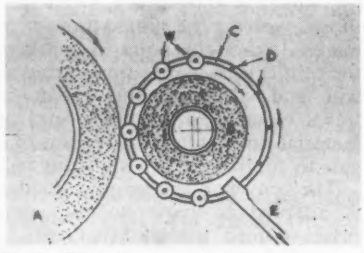


Fig. 3.—Illustrating the principle employed for grinding diameter of small wheels for counting machines

The advantages of this system compared with other methods available for the same work is that it ensures concentricity and squareness of the outer diameter with the hole, as well as the close accuracy on size which is a feature of the centreless process, all three points being of extreme importance for the instruments in which such pieces are used. Production of typical pieces is about 4,000 pieces per hour, with a stock removal which may on occasion be up to 0·018 in. (0·45 mm).

Emergency Stop for Armoured Conveyors

A system which provides a simple means of stopping an armoured conveyor instantly in case of emergency has been devised by Mr. G. V. Jones, electrical engineer at Bold Colliery, North Western Division of The National Coal Board. It has been used successfully at Bold, Wood and Sutton Manor Collieries. The system is applied to an Anderton Shearer-Loader installation but can be adapted for use in installations where other machines work in conjunction with the armoured face conveyor.

The essence of the system is to link the conveyor control circuit with the power loader circuit in such way that when the emergency stop switch on the loader is actuated, the conveyor is also halted. This is effected by connecting an extension circuit into the sequence control of

the multi-motor panels. This extension circuit passes through the power loader control box where two auxiliary switches, mounted in parallel, are provided. Thus when either switch is closed the conveyor will operate normally, but when both auxiliary switches are open the conveyor circuit is broken and the conveyor stops. These auxiliary switches, A and B, are so arranged that switch A is normally closed and switch B is open when this power loader is shut down, so that the conveyor can be operated independently of the power loader. When the power loader is started, switch B is closed before switch A is opened, the closing of switch B maintaining the interlock circuit of the multi-motor panels and allowing the conveyor to be run.

If the motor of the power loader is stopped, switch B opens automatically, shutting down the multi-motor panels and stopping the conveyor. By means of a timing mechanism, automatic reclosing of switch A is delayed to allow all contactors in the multi-motor scheme to open. Normal conditions are then automatically obtained for restarting.

An additional circuit is provided, also leading into the loader box, to illuminate a Heyes's F.L.P. visual indicator when the emergency stop is employed. Operation of the loader box actuates another switch C in this indicator circuit.

A duplicate emergency arrangement is fitted in the pre-cutter box when a pre-cutter is used in conjunction with a power loader.

Heat Insulating Bearing

In the design of aircraft for supersonic flight, problems arise due to heating of the aircraft structure at very high speeds. Where it is desired to use light alloys, air conditioning is used to keep the components down to temperatures at which the strength of light alloys is unaffected. This treatment may not be fully effective for certain parts in intimate contact with the heated aircraft structure, for example, undercarriage attachments.

Undercarriages take heavy loads on landing and great structural strength is required; but this strength is not needed in the retracted position when the problems of heating arise. A heat insulated bearing, designed by Electro-Hydraulics Limited, which may be used in these circumstances is illustrated in Figs. 1 and 2.

The bearing is formed in two parts; part 2 has high strength and part 3 has good insulating properties. The shaft 1 which is to be supported has high strength. In Fig 1, the shaft, which is cut away at 4, is in contact with the high strength part 2 of the bearing to take landing loads. In this position the speed of the aircraft is relatively low and the heating problem does not arise. Fig 2 shows the shaft rotated into the undercarriage retracted position and supported by part 3 of the bearing. The shaft is insulated from part 2 which may be at high temperature.

Fig 3 shows an application of this type of bearing to take loads in two planes. The shaft is supported in a bearing 5 of good insulating properties and may also be supported in two bearings sections of high strength to take loads in two planes. These are shown at 6 and 7. When the shaft is rotated through 90° it is supported in the high strength part bearings.

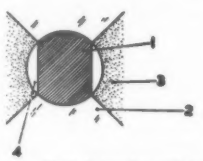


Fig. 1.—Shaft in bearing position

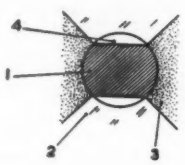


Fig. 2.—In heat resisting position the shaft is turned so that the flats are clear of the heat source

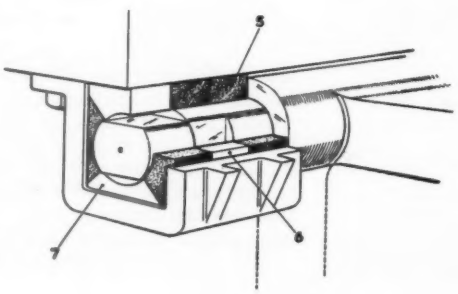


Fig. 3.—Design for a composite heat resisting bearing to withstand loads in two planes

Circulation Assists Spray Painting with Heavy Pigments

A problem frequently met in spray finishing is that of feeding to the spray gun a material which is heavily pigmented, and which readily settles out when not being used. Almost every manufacturer who is spraying filler as part of his finishing process is familiar with the difficulties which can be encountered after work has been interrupted for only a few minutes. The material, after leaving the pressure container, may settle out in the hose, and spraying cannot be resumed without considerable waste of time and filler.

Alfred Bullows & Sons Limited, having encountered this problem in their own production, offer a simple and inexpensive solution. The Bullows Pogo pump is used to feed the material through a standard fluid hose to the spray gun, to which

A Y-piece on the feed inlet to the spray gun and a return pipe to the container keeps the paint in circulation and prevents heavy pigment from settling

is attached a Y-piece. From the Y-piece a second length of hose provides a return flow to the pump and thence to the container of material, which is itself kept agitated by this constant flow and return of material. This very simple arrangement has now been operating for just over 18 months, running day and night, and it is possible to pick up the gun and spray filler at any time, without any stoppage at all.

The immediate application for this new development will be in the machine tool industry and similar trades where finishing of castings is carried out on a large scale. Since many machine tool finishers use a metallic paint, the same technique can be used to overcome its propensity for settling out.

Review of Progress with Research and Power Reactors in Euratom Countries

By J. R. FINNIECOME, M.Eng., M.I.C.E., M.I.Mech.E., F.Inst.F.,
Consulting Engineer

THE first International Conference on the "Peaceful Uses of Atomic Energy" took place at Geneva in August, 1955. It proved to be one of the largest gatherings of scientists ever held, for it was attended by 1400 delegates and members from 73 countries, and of the 1225 papers published, 460 were discussed in detail. In addition two specially planned exhibitions were held, one of a more scientific nature and the other of general interest. Since then, also, Europe has become conscious of the paramount importance of nuclear power for the generation of electricity.

Undoubtedly the conference was an outstanding success, particularly from the point of view of promoting international co-operation in the design and development of research of nuclear reactors, specially suitable for large base load power stations and marine propulsion. Furthermore, it had the desired result of encouraging the establishment of international organizations and agencies, particularly in Western Europe. As these are ultimately to be of vital significance to the future progress of the various countries it is proposed to summarize very briefly the essential facts and to direct special attention to the advances in Euratom countries—Belgium, France, Holland, Luxembourg, West Germany and Italy.

1. European and International Organizations and Agencies

The establishment of an international research organization in Western Europe originated in a resolution of the 5th UNESCO General Conference in June, 1950, two months before the first International Conference at Geneva. The main object was to achieve the economic integration of Western Europe. The number of organizations and agencies has increased considerably since then. This is indicated in Table I which summarizes the essential particulars of twelve. These are all playing a dominent part in the development and advancement of nuclear power. In order to be able to appreciate more fully their primary object it is proposed to present some of their special features.

1.1. European Council of Nuclear Research (C.E.R.N.)

This establishment is generally known as "Conceil Européen pour la Recherche Nucléaire", therefore by the French initials "C.E.R.N." It was proposed by Professor I. I. Rabi of the U.S.A. in June, 1950, at the General Conference of UNESCO at Florence. In November, 1951, a group of experts from eight European countries presented to UNESCO their propositions. The creation of a laboratory was approved in February, 1952, at a conference at which twelve European nations were present. At Copenhagen in June, 1952, four sites were proposed for the laboratory: Arnheim, Copenhagen, Geneva and Paris. In October, 1952, at Amsterdam, Geneva was finally selected and work on site was started in September, 1954, The original twelve member States

Table I.—EUROPEAN AND INTERNACIAL ORGANIZATIONS AND AGENCIES

1	2	3	4	5	6	7	7
Item	Organization or Agency	Abbreviation	Head-quarters	Date of inital proposal	Date of final agreement	Date in force	Number of members
1	European Council of Nuclear Research (Conceil Européen pour la Recherche Nucléaire)	C.E.R.N.	Meyrin near Geneva	1950	1952	1954	13
2	European Atomic Energy Community	Euratom	Brussels	June 1955 (Messina)	March 1957 (Rome)	Jan. 1958	6
3	European Company for the Chemical Processing of Irradiated Fuels	Eurochemic	Brussels	July 1956		Jan. 1958	12
4	International Atomic Energy Agency	I.A.E.A.	Vienna Kärntner Ring 11	December 1953	Oct. 1956 (New York)	July 1957	70†
5	European Nuclear Energy Agency (Associated with O.E.E.C.)	E.N.E.A.	Paris	June 1955	December 1957	Feb. 1958	16
6	Organization of European Economic Co-operation	O.E.E.C.	Paris Château de la Muette			April 1948	17
7	European Coal and Steel Community	E.C.S.C.	Strasbourg	May 1950	April 1951	April 1951	6
8	European Common Market	E.C.M.	Strasbourg			April 1951	6
9	European Free Trade Association	E.F.T.A.	Geneva		November 1959 (Stockholm)	July 1960	7*
10	Euratom–U.S. Agreement	Euratom-U.S.			November 1958	May, 1959	
11	Euratom—U.K. Agreement	Euratom—U.K.			Feb. 1959 (London)		
12	Euratom—Canada Agreement	Euratom—Canada			October 1959		

*"Outer Seven"
†July, 1959

are:

Belgium	Netherlands
Denmark	Norway
France	Sweden
Federal Republic of Germany	Switzerland
Greece	United Kingdom
Italy	Yugoslavia

In July, 1959, Austria joined C.E.R.N., therefore the membership has increased to 13.

C.E.R.N. is particularly concerned with pure nuclear research. Its laboratory is located at Meyrin, about 5 miles north west of Geneva on the main road to Lyons near the French border. The principle experimental equipment is installed in four laboratories and consists of a 600 MeV · synchro-cyclotron, a 25 GeV proton synchrotron and a 50 MeV proton linear accelerator. The essential particulars are indicated below:

(1)	Synchro-cyclotron	
(a)	Maximum energy	600 MeV
(b)	Weight of magnet	3000 ton
(c)	Floor space of the building: length	17 m = 55 ft 9 in.
	width	16 m = 52 ft 6 in.
(d)	Thickness of the concrete walls	6 m = 19 ft 8 in.
(e)	Total weight on foundations (including shielding)	18,000 ton
(f)	Work started on site	17/5/1954
(g)	Date of plant in operation	August 1957
(2)	Proton-synchrotron (Designated "EUROTON")	
(a)	Maximum energy of protrons	25 GeV
(b)	Weight of steel magnet (approx.)	3200 ton
(c)	Weight of coils (approx.)	110 ton
(d)	Mean power dissipated in the magnet	1·5 MW
(e)	Maximum magnetic field	12,000 gauss
(f)	Diameter of magnet ring	200 m = 656 ft
(g)	Depth of magnet ring	3·5m = 11ft 6in.
(h)	Height of magnet ring	5·2 m = 17 ft
(i)	Number of magnet units	100
(j)	Length of each magnet unit	5.0m = 16ft 5in.
(k)	Weight of each magnet unit	30 ton
(l)	Work started on site	17/5/1954
(m)	Date of operation for the first time	16/9/1959
(n)	Full power for the first time	Nov. 1959
(o)	Total cost (approx.)	£6 million
(p)	Thickness of concrete walls	20 ft
(3)	Proton linear accelerator for proton-synchrotron	
(a)	Maximum energy of protons	50 MeV
(b)	Total length	100 ft
(c)	First section (40 ft long weighing 9 tons) despatched from the manufacturer's works	July 1957
(d)	Date of operation	1959

These exceptionally high-energy particle accelerators enable more advanced physical research to be conducted on the nature of the atomic nucleus. It is particularly significant that the energy of these two accelerators is considerably higher than current practice. This is indicated in Tables II, III, IV which give the energy of large synchro-cyclotrons, proton synchrotrons and proton linear accelerators in operation or under construction in Europe, U.S.A. and U.S.S.R.

In this epoch of rapid advances in high-energy particle accelerators it is particularly important to emphasize that there are over one hundred of different types and electrical energy in operation at a number of research establishments and universities in many countries of the world. However, the most recent major projects on synchro-cyclotrons of 170 MeV and above, on proton synchrotrons of 7 GeV (7000 million electron volts) and higher, and on 50 MeV proton linear accelerators are recorded in Tables II, III, IV respectively. On examining these tables one finds that

(a) C.E.R.N's laboratory can proudly claim to have in operation a 600 MeV synchro-cyclotron, a 25 GeV proton synchrotron and a 50 MeV proton linear accelerator, for these are at the moment the largest in the world. This long-term programme was planned in 1954 and completed by the end of 1959, after five years of remarkable achievements in design, development, manufacture and civil engineering work.

(b) C.E.R.N's 600 MeV synchro-cyclotron has 50% more energy than the second largest in the world, installed at Liverpool University in 1954.

(c) A proton synchrotron, having the same electric energy (25 GeV) as C.E.R.N's is under construction at the Brookhaven National Laboratory, Long Island, U.S.A.

(d) A 50 MeV proton linear accelerator, the same as C.E.R.N's, has been in operation at the Rutherford High Energy Laboratory, Harwell, since July 12, 1959, i.e., four months before C.E.R.N's. Both were designed and manufactured by Metropolitan-Vickers Electrical Company. C.E.R.N's proton linear accelerator reached its design energy on November 24, 1959, by producing a beam of protons of an energy of 24 GeV (24,000 million electron volt).

(e) The largest accelerator in U.S.S.R. is the 10 GeV proton synchrotron, operating since February, 1957, at the Joint Nuclear Research Institute at Dubno on the Volga. It first produced the designed energy in May,

Table II. SYNCHRO-CYCLOTRON

Item	Location	Country	Energy MeV	Operation
(a)	C.E.R.N.	Switzerland	600	Aug. 1957
†(b)	Rutherford High Energy Laboratory (Harwell)	United Kingdom	170	1949
†(c)	Liverpool University	United Kingdom	400	1954

†Designed and manufactured by Metropolitan-Vickers Electrical Company

Table III.—PROTON SYNCHROTRON

Item	Location	Country	Energy GeV*	Operation
(a)	C.E.R.N.	Switzerland	25	Nov. 1959
(b)	Brookhaven National Laboratory, Long Island	U.S.A.	25	Under construction
(c)	Argonne National Laboratory	U.S.A.	12·5	Under construction
(d)	Rutherford High Energy Laboratory (Harwell)	United Kingdom	7	Under construction
(e)	Joint Nuclear Research Institute (Dubno)	U.S.S.R.	10	Feb. 1957
(f)	Moscow	U.S.S.R.	7	Under construction
(h)	Moscow	U.S.S.R.	50	Planned

Table IV.—PROTON LINEAR ACCELERATOR

Item	Location	Country	Energy MeV	Operation
†(a)	C.E.R.N.	Switzerland	50	Nov. 1959
†(b)	Rutherford High Energy Laboratory (Harwell)	United Kingdom	50	July 7, 1959

†Designed and manufactured by Metropolitan-Vickers Electrical Company
*Giga electron volt = 1,000 million electron volt: 1,000 MeV

1957. The weight of the magnet is 36,000 ton and the orbit diameter is 56 m (183 ft 8 in.).

(f) A 50 GeV proton synchrotron has been planned in U.S.S.R. for the nuclear physic research establishment at Moscow. It will have twice the energy of that at C.E.R.N. and Brookhaven National Laboratory, Long Island, U.S.A., which are the largest in the world to-day.

The essential characteristic features of the principal accelerators are summarized in Table V. The approximate cost of a number of these is indicated in Table VI.

On the basis of the cost per MeV, item 4, the 50 GeV proton synchrotron, planned by U.S.S.R., would cost between 35 to 50 million pound sterling.

The Eastern European Countries have established the Joint Nuclear Research Institute at Dubno on the Volga. It is an international organization, similar to C.E.R.N., and the following nations are members:

Albania	Rumania
Bulgaria	Soviet Union
Hungary	China
East Germany	Northern Korea
Czechoslovakia	Mongolia
Poland	

This Eastern Research Institute has four principal laboratories, similar to those at C.E.R.N., which are mainly concerned with:

(a) Nuclear problems
(b) High energy accelerators
(c) Neutron physics
(d) Theoretical physics

The experimental work is, at the moment, carried on the two recently installed particle accelerators:

(a) 10 GeV proton synchrotron
The essential particulars are:

Outside diameter of the magnet	72 m = 236 ft 2 in.
Mean diameter of the magnet	56 m = 183 ft 8⅛ in.
Air gap between the magnet quadrants	8 m = 26 ft 3 in.
Number of quadrants of the magnet	4
Number of block per quadrant	12
Total number of blocks	48
Weight of each block	750 ton
Total weight of magnet including windings	36,000 ton

(b) 600 MeV synchro-cyclotron
(c) 10 MeV proton linear accelerator
(Used for the intial acceleration of the protons in the 10 GeV proton synchrotron).

It is of interest to remark that the 10 GeV proton synchrotron is 40% of C.E.R.N's, whilst the 600 MeV synchro-cyclotron has the same energy.

At the beginning of December, 1959, the most costly equipment at C.E.R.N., the nominally 25 GeV proton synchrotron, was operated at 30 GeV, which must be regarded as a significant achievement.

Table VI.—COSTS OF PARTICLE ACCELERATORS

Item	Type	Energy	Total cost	Cost per MeV
1	Sunchro-cyclotron (Liverpool University)	400 MeV	£750,000	£1,877
2	Synchro-cyclotron (C.E.R.N.)	600 MeV	£1,470,000	£2,450
3	Cosmotron (Brookhaven, Long Island)	3 GeV	£2,500,000	£833
4	Proton synchrotron	30 GeV	£20 to £30 million	£667/1,000

Table VII.—COSTS AT C.E.R.N.

Calendar Year	Total capital investment and operating cost	
	Million Swiss Francs	£ Million
1956	34	2·83
1957	62	5·16
1958	56	4·66
1959	55	4·57
1960	65	5·40
Total to end of 1960	272	22·62

Table VIII.—CONTRIBUTIONS TO COSTS OF C.E.R.N.

	Country	% of total
1	Belgium	4·88
2	Denmark	2·48
3	France	23·84
4	West Germany	17·70
5	Greece	0·97
6	Italy	10·20
7	The Netherlands	3·68
8	Norway	1·79
9	Sweden	4·98
10	Switzerland	3·71
11	United Kingdom	23·84
12	Yugoslavia	1·93
	Total	100·00

Table V.—PRINCIPAL TYPES OF PARTICLE ACCELERATORS AND THEIR CHARACTERISTIC FEATURES

1	2	3	4	5	6	7	8
Item	Type of particle accelerator	Path of accelerated particles	Path maintained by	Acceleration of the particles by	Establishment responsible for first original design in the world	Year of operation of the first in the world	Remarks
1	Cyclotron	Expanding spiral	Guiding magnetic field	Electrostatic field produced by a radio-frequency oscillator	Berkeley University. (Experiments begun by Prof. Ernest Lawrence in 1929) California.	1929	Suitable for accelerating heavy particles, protons, deuterons and α particles. Energy limited to 50 MeV. (First cyclotron was only 6 in. across)
2	Betatron	Circle	Changing magnetic flux	An alternating magnetic field	Berkeley University, California. (D. W. Kerst)	1941	U.S. patent No. 1, 645304, filed March 1922 by I. Slepain. First machine made by D. W. Kerst in 1941. Experiments conducted at Berkeley University, California.
3	Synchrotron	Circle	Guiding magnetic field	Synchronous electric impulses	A.E.R.E. (Harwell) and T.R.E. (Malvern)	August 1946	First electron synchrotron was begun towards the end of 1945 and an 8 MeV was working at Harwell Aug., 1946.
4	Synchro-cyclotron	Expanding spiral	Guiding magnetic field	Synchronous electric impulses	A.E.R.E. (Harwell) and T.R.E. (Malvern)	1946	Also known as a "Frequency modulated cyclotron".
5	Linear	Straight line	Electro-magnetic wave	Very short electro-magnetic waves generated by high power magnetron valve.	T.R.E. (Malvern)	November 1946	The first travelling wave linear accelerator operated Nov., 1946. Its energy was ½ MeV. A larger one of 4 MeV was started up at Malvern, 1948.

Table IX.—STAFF AT C.E.R.N.

Year ending 31st December	Number of staff
1955	286
1956	396
1957	598
1958	625

Table X.—C.E.R.N. DEPARTMENTS

	Department or Division	Number of staff
(a)	Secretariat of the Director-General	8
(b)	Proton synchrotron division	167
(c)	Synchro-cyclotron division	92
(d)	Scientific and technical services	57
(e)	Site and building division	177
(f)	Administration division	79
(g)	Theoretical research division	7
(h)	Scholarship holders	38
	Total	625

A full appreciation of the total of the capital investment and the operating cost of C.E.R.N. for the years 1956 to 1959 and those estimated for 1960 can best be gained from an examination of the values presented in Table VII which reveals that up to the end of 1959 the total expenditure was 207 million Swiss Francs (£17·22 million) and the proposed budget for the year 1960 is 65 million Swiss Francs (£5·4 million), thus making a total to the end of 1960 of 272 million Swiss Francs £22·62 million).

The scale for the basis of the assessment of contributions of the twelve member countries, for instance, for the year ending on December 31, 1956 is indicated in Table VIII as a percentage of the total.

This scale of assessment applied also to the years 1957, 1958 and 1959.

The staff of C.E.R.N. has increased year by year with the continual expansion of the laboratories and the services and this is demonstrated in Table IX for the years 1955 to 1958 inclusive. The numbers exclude the 14 consultants. The distribution of the staff over the various departments and divisions on December 31, 1958, is shown in Table X.

Note: The scientific and technical staff is about 65% of the total personnel.

To be continued.

Handling Materials in Bulk

A completely new range of mechanized equipment for handling in bulk process materials of many types, waste products and general refuse known as the "Dempster-Dumpster" system is manufactured under licence in the United Kingdom by Powell Duffryn Engineering Company Limited, at their Cambrian Works, Cardiff.

The Dempster system is an integrated system of vehicles and containers designed to facilitate economic handling of all types of materials in bulk and requiring less labour and equipment than conventional methods. Utilizing most standard makes of commercial chassis and cab with Dempster equipment, versatile, tailor-made systems can be devised to meet practically any requirement for the collection, transportation and dumping of a wide range of materials.

Containers of various types from 1 cu yd to 15 cu yd capacity and up to 9000 lb laden weight can be lifted to a dumping height of 10 ft, or automatically self-loaded into compaction bodies of 18, 24 or 30 cu yd capacity. One vehicle can pick up or set down hydraulically its own body of up to 40 cu yd capacity. In certain instances the large detachable containers can be used as portable dumps or transfer stations. Their large capacities make the long haul to distant disposal areas economical and provide the necessary storage space at points of volume accumulation. There are five main types of vehicle within the range.

High Strength Concrete Aggregate

THE Lafarge Aluminious Cement Company Limited announce a new synthetic aggregate for use with Ciment Fondu high alumina cement, which makes a concrete of high density, hardness and strength in 24 hr, and it is also heat resistant. The new product, called ALAG, resembles a crushed basalt aggregate. It has a chemical affinity for high-alumina cements.

Alag is dense, non-absorbent and has a hardness of 7·0 to 7·5 mohs (between quartz and topaz) and will cut glass. The concrete will withstand temperatures up to 1200° C. Alag is primarily used as a special aggregate with high-alumina cement (Ciment Fondu) and should not be used with Portland or super-sulphated cement.

After 24 hr the compressive strength of Alag concrete is 13,000 psi compared with 7500 psi for normal Ciment Fondu concrete (after 7 days Ciment Fondu/Alag concrete has a compressive strength of 16,000 psi). This strength is approximately maintained through a heat range of 600° to 1200° C, figures for the higher temperature being 3800 psi compared with 2800 psi for ordinary refractory concrete.

Density is approximately 170 lb/cu ft air-dried, 20 lb/cu ft greater than ordinary structural aggregates, and about 40 lb/cu ft greater than refractory concrete made with an aggregate of crushed firebrick, to which the expansion characteristics are similar.

Pumping Viscous Adhesives

Recently National Adhesives Limited, Slough, were faced with the problem of pumping polyvinyl acetate emulsion of 12,000 sec viscosity from portable storage vessels into large processing vats. The requirement was for a light-weight portable pump unit which could handle 2000 gph of PVA emulsion, approximately 55% solids at 20 ft head without agitation or centrifugal action. Various methods of pumping were first tried but all failed due to seizing-up or to over agitation of the emulsion or on economical grounds. Success was eventually found in a Goodyear Size 7 positive displacement pump which employs bonded elastomer-to-metal parts to reduce wear and provide sealing between moving components, manufactured by Goodyear Pumps Limited, 44, Brook Street, London, W1.

The increased viscosity caused through gradual solidification during shut down periods was easily overcome by manually turning the rotor before starting the electric prime mover. Further, the axial flow action of the Goodyear pump did not agitate the liquid harmfully. Extensive tests were carried out, one of which involved the pumping of 10 gal of emulsion for 24 hr, followed by physical and chemical examination of the liquid. The results showed no change in its physical structure or any sign of water separation.

Metallurgical Developments

This second article deals with recent advances in new processes and materials for marine and other engineering applications

PACK carburizing and allied heat treatment procedures now used for low alloy case hardening steels have been developed mainly on the basis of experience with low carbon steels. These techniques have, however, not proved entirely suitable for alloy steels. Research has been devoted, therefore, to the production of a carburizing compound capable of giving the desired results. It has been found that with a 4.25% nickel chromium molybdenum steel, for example, a 1% sodium carbonate or a 2½% barium carbonate compound provides a satisfactory medium for carburizing. Water-soluble energizers must, however, be used to ensure adequate bonding of the chemical to the charcoal in the compound.

A general investigation has been made of the possibility of improving high temperature strength in 80-20 chromium nickel alloys by the admixture of powders of refractory type. It has been found that a liquid-phase sintering technique gives the most successful results. The thermal shock properties of the metal-oxide materials is adequate, and the oxidation resistance good, though not quite so high as that of the plain 80-20 chromium nickel alloy. Stress rupture tests showed a stress of 2.75 ton per sq in, which is three times that of the ordinary alloy under identical conditions. At 1080°C the liquid phase sintered material has double the strength of the non-oxide-containing alloy. Room temperature strengths are consistently about 33.5 ton per sq in.

Extrusions in stainless steels offer the designer a large number of advantages, such as freedom of section design; reduction or elimination of machining operations; production of integral shapes normally produced only by joining two or more components; economical production of small quantities of components when demand does not justify rolling; production of shapes impossible to roll or unavailable in the quality of steel required; improved mechanical properties in parts subject in service to transverse loading; and economies over cast or forged components. The extrusion process has been developed to render the achievement of these advantages possible. Stepped, tapered and multiple extrusions in stainless steel are now possible. Shapes can be modified for the extrusion process.

When 13% straight chromium steels are tempered after rapid cooling at 500–600°C the corrosion rate is found to increase, probably because of the proportion of chromium carbides. When, however, tempering is carried out at 700°C, corrosion is reduced, probably because the chromium is more uniformly distributed. Welded parts are usually deeply corroded, but it has been found that this can be prevented by tempering at 700°C after welding.

The pitting of steel in crude oil tankers has been investigated and has been found to occur as the result of an electro-chemical reaction in almost neutral electrolytes of high conductivity. Cleaning the tanks by hot sea water contributes a great deal to corrosive attack, and it has been found that resistance to corrosion shows a definite minimum at a certain level of the alloying elements of the steel. It has been concluded that the pitting is a combined effect of cavitation caused by the hot sea water jets and of corrosion.

A new process of coating metal surfaces has been developed, and is produced by flocculating a silicon oxide gel under special and standardized conditions, followed by an ageing treatment. The film of oxide absorbed on the metal surface reacts with the silicon oxide film to form a thin silicate bonding film, which resists temperatures up to 400°C and does not impair the polish of the metallic surfaces.

A bonding process for uniting aluminium and stainless steel has been announced. Known as pressure bonding, it renders possible the use of aluminium in combination with such metals as carbon and alloy steels, copper, and other aluminium alloys. A process of lamination also recently developed consists of permanently fusing a solid vinyl film by extreme heat and pressure to chemically treated steel and aluminium, combining the strength, rigidity and impact resistance of metal with the beauty, colour and texture of the vinyl.

Extrusion is being applied not only to stainless steels, as earlier described, but also to aluminium ingots. The extruded metal, specially manufactured for the process, is being used for railings, decking, masts, brackets, and many other structural uses. It is said to give higher extrusion speed, superior mechanical properties and a better finish, than ordinary aluminium alloys.

A new British process is a method of coating cast-iron with tin. It is known as the direct chloride method, and involves preparing the castings by blasting them with a superfine grit and then using a special, inexpensive tinning flux.

Explosion-forming is a new process which is proving extremely useful for certain types of work, and particularly those which are difficult or impossible by other methods. Most of the work involves the use of cartridges, powder charges, shaped charges or high explosives, with or without the use of tools. The process is being employed as a means of forging, extruding, cold welding, piercing holes, cutting large billets, work hardening, embossing, flattening sheets, elongation of carbon steel by 70% as against the normal limit of 42%, and compacting powdered metals.

The marine applications of existing materials are, as always, interesting. A new steel-hull corrosion-proof boat launched last year measured 28 ft in length, and was designed to demonstrate a unique system of corrosion control. In operation, current flows from a tiny platinum

anode through the sea to the hull of the boat, neutralizing corrosive action. This use of electricity to arrest corrosion is regarded as a major break-through in the protection of mass-produced steel-hull pleasure boats. This is the same system as is installed on the new Forrestal-class aircraft carrier 'Independence', the atomic submarine *Triton* and many other large naval and merchant ships. Now miniaturized for small boats, the system needs only $\frac{1}{2}$ oz of platinum in the anode structure and can be obtained at a price within the means of owners of pleasure boats. Electrical requirements are said to be so small that even on an idle boat the battery will operate the system for three months. The reference cell and electrical equipment for the unit are encased in a chromium-nickel stainless steel housing, installed below the cockpit floor and accessible through the hatch. The anode is assembled through the hull, but insulated from it by a blanket of neoprene, which prevents high current concentration in the immediate area of the anode and spreads protection to the entire hull. Power of the cruiser is transmitted by nickel-copper alloy shafts to nickel-aluminium bronze propellers. Nickel-cadmium storage batteries, nickel-copper alloy gas and water tanks, stainless steel trim and deck hardware, nickel-copper alloy anchors, mufflers, chlorinator and fuel lines, complete the corrosion-proofing of the new craft.

When the nuclear submarine *Nautilus* travelled under the Arctic ice-cap, clean hot water was still being supplied to the crew. Three units supplied all the hot water for galley and washrooms, being nickel-copper alloy water heaters, of certified welded construction, and adapted for a.c. or d.c. operation, with a nominal rating of 6000 watts. In normal marine use they have an unlimited life, and are the result of a co-operative design effort. They have to withstand not only the long-term effects of the fresh water they handle, but also the potential danger of the marine atmosphere. The alloy was chosen for the heater tank and fittings because its resistance to corrosion keeps the water fresh and pure.

The Cunard liner *Sylvania*, 22,000 tons, is using nickel and nickel alloys for valves, seats, reduction gearing and numerous other applications in the engine room. Stainless steel has also been extensively used in the ship's galley. Two of the geared turbines designed for steam at 550 psi steam and 850°F make use of nickel in parts of the main propelling machinery. Controls on the main starting platform gauge board and the turbo-generators also use nickel and nickel alloys.

New 120-ft diesel-powered tugboats are being fitted with such modern luxuries as a sound-proofed engine room, a heating system that maintains an inside temperature of 70°F when outside the temperature is zero, and a 5-ton air conditioner for hot-weather comfort. The *S. M. Jenks* is the third vessel of this type ever to be built with all-stainless steel hull construction, the plates of which are welded with 25-20 lime-coated electrodes. In addition, nearly eight tons of stainless steel forgings and castings have gone into the ship. The streamlined rudders and the twin propeller shafts, the stern tubes, the two sea-chest compartments, the plate strainers, the tubing for the heat exchangers, the stern struts and propellers, as well as galley parts, are all made of stainless steel of various compositions.

H.M.S. *Dark Aggressor*, a new high-speed submarine chaser, is powered by a diesel engine of new design which makes use of aluminium pistons with nickel-chromium alloy iron ring carrier bands. These bands carry the top piston ring, precisely where the heat, wear and pounding would normally cause rapid breakdown of the aluminium alloy. The alloy iron band is metallurgically bonded to the aluminium piston by a special process. Advantages of this type of engine are low weight and space, ease of maintenance and freedom from vibration.

Chilled fresh orange juice to the extent of 650,000 gal is transported each week from Florida to New York. A cast stainless steel pump is used to transfer the juice from the hold of the ship to the receiving plant. The temperature of the juice rises one or two degrees, and therefore to restore the temperature to 29°F, the juice is put through a chiller. At each end of this unit are two heads of chromium nickel stainless steel castings, with numerous flow control return bends cast in.

Drumless boilers operating at 700°F and 4300 psi are now practical with high nickel copper alloy tubing. In addition to its resistance to corrosion, the high strength of the alloy allows the walls of the tubes to be thinner than is possible with other alloys, and this ensures the most satisfactory transfer of heat, it is claimed.

Ships at sea can now tell how fast they are travelling by means of a new marine speedometer, which is claimed to be the most accurate yet developed. As the device is electrically operated, some of the components are being made of a non-magnetic nickel copper cast alloy, while other parts are made of an alternative nickel copper alloy which is of free-machining type.

The first American passenger liner to be built in America for six years is the *Santa Rosa*, and is the first American ship to be fitted with gyro-fins for stabilizing the vessel in rough weather. She is designed exclusively for cruising in tropic seas, and has generous space for outdoor recreation. Her swimming pool and beach area are clad with high nickel-copper alloy, which gives corrosion resistance, easy maintenance and handsome appearance, as well as the strength of structural steel. The fin flaps of the gyro-stabilizer are hinged with age-hardening cast nickel-copper alloy, chosen because of its strength, toughness, hardness and resistance to corrosion for this critical part of the fin assembly.

A deep sea tanker takes heavy punishment when rough seas are encountered. With each pitch and roll she has to weave, and her five miles or more of piping have to weave with her. In some tankers grey cast-iron pipe resists corrosion for ten years or more, but it may be cracked and broken by the pounding of heavy seas. In other tankers steel pipe functions in storms without damage, but it undergoes severe corrosion when handling sour crude oil and may have to be replaced every three or four years. It has now been found by tanker owners that ductile iron pipe combines the low cost and established corrosion resistance of cast-iron with the toughness and strength of carbon steel. Today many tankers are carrying pipe and fittings of this type of iron. Ductile iron cargo piping, for example, has recently been installed in three new ocean-going petroleum tankers.

A new stainless steel strut and rudder combination is now being used by the oil industry in South America. The 52 ft workboats are called upon to turn and twist rapidly in the brackish waters of coastal inlets and bays. The waters are unusually corrosive, being heavily charged with salt and chemicals. A softer material had to be replaced too often. The stainless steel strut is a casting of 60 lb and the rudder 110 lb. Two struts and

rudders are used in each boat. Costs were reduced because each item could be cast in one unit instead of being a welded assembly of small pieces. The boats are used to haul equipment and transport personnel to offshore drilling rigs.

Nickel aluminium bronze has proved its reliability in a marine job demanding smooth performance. This is on board the tanker *Florida*, where the main circulating pump forces 16,000 gpm of sea-water through the ship's main condenser. The impeller in this pump has to have superior resistance to corrosion and erosion from high velocity sea water, and is therefore made of the alloy mentioned.

Cupro-nickel alloy of 70% copper and 30% nickel has been chosen by the U.S. Navy for impellers to handle sea water in close-coupled centrifugal pumps. The alloy was chosen because of its corrosion resistance, strength and dependable performance at temperatures ranging from below zero to 750°F. This alloy is more weldable than other bronzes.

Sonar under-water detection uses a remarkable property of nickel, which changes slightly in length when magnetized. Known as magnetostriction, this property is capable of converting electrical power into mechanical vibration or sound. In underwater detection it operates a transducer made of nickel and energized by a permanent magnet.

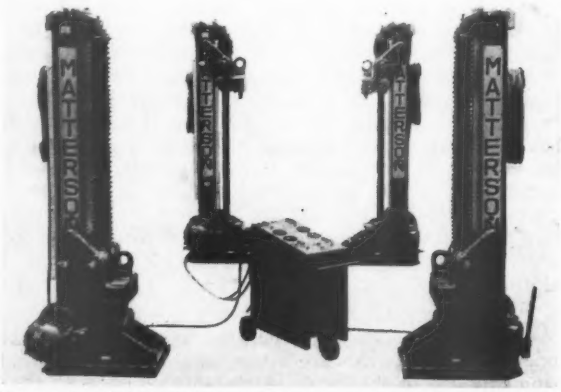
Welding developments have not been quite so numerous as in former years. Of all the so-called problem joints, the welding of copper to stainless steel is regarded as one of the most difficult. It is now being satisfactorily performed by means of special electrodes containing nickel or with a nickel-containing filler wire. Welds show uniform contour, good fusion and good penetration. A cross-section of the weld after it has been etched and macro-examined shows no porosity, cracking fissures or slag inclusions. The joint of the copper to the steel is strong, ductile and sound. A short gauge tensile test of a weld of this type broke in copper only after reaching about 15 tons per sq in.

The effects of porosity on the mechanical properties of a wide range of arc welds in low carbon steel have been investigated and it has been ascertained that the cross-section of the welds can be reduced by up to 7% without materially affecting the mechanical properties measured. The size or amount of porosity was the most important factor, its shape or distribution having little effect.

The development of a technique for butt-welding very thin sheets of stainless steel has been announced. The arc is started by using argon, but the actual weld is made with helium as a gas shield. Although the sheets are clamped and moved under a fixed welding head, the process is not to be regarded as fully automatic, because the final quality of the weld depends on the judgment of the operator.

It has been revealed by earlier work that the tendency of alloy steels to cold-crack in the heat-affected zone during metallic arc welding relates to the structural changes occurring in the steel during cooling. It has been found that the cooling temperature at the specified rate of welding is governed by the type of welding electrode used, and is lowest for electrodes giving welds of low diffusible-hydrogen content. It has also been shown that there is possibly a critical temperature for rutile-coated austenitic electrodes in the region below about 200°C. Residual hydrogen is sufficient to lower the dead-load rupture strength of a low alloy steel to a value below 40 tons per sq in.

A new welding electrode for columbium-stabilized stainless steel used for steam piping has aroused considerable interest. It contains 16% chromium, 8% nickel, 2% molybdenum. It has been established that while not entirely overcoming cracking in this type of steel, it does make an important contribution towards the solution of the problem.



Group of large hydraulic jacks arranged for group working from one control desk

Electric Jacks for Group Working

As part of the modernization plan for the Longsight depot in Manchester, British Railways have selected Matterson 20-ton electric screw-type jacks for locomotive servicing. This is a new type of jack made by Matterson Limited of Healey Works, Shawclough, Rochdale, and part of a range which at present also includes 16 and 25 ton models.

The new jacks will raise 20 tons on a projecting pad to a height of 7 ft 1½ in. from floor level, from a minimum height of 2 ft 3½ in. Normally used in groups of two, three, or four, they are connected by trailing wires to a portable control desk which is similarly connected with the mains supply. Each jack has a numbered switch and a master switch energizes the selected contactors simultaneously to operate the jacks upwards or downwards as required.

Ammeters indicate load distribution and limit switches cut out all connected jacks whenever a single jack reaches the upper limit of travel, but the other jacks can be moved upwards after the one at its upper limit has been switched off. The lower limit switch only cuts out the jack concerned, the others returning to the bottom position if the master switch is kept depressed.

The mechanism consists of a 3 hp electric motor driving a worm and spur reduction gear which turns the vertical lifting screw, giving a lifting speed of 6 in. per min. A square shaft extension allows manual operation in emergency. The reaction of the overhung load is taken by hardened rollers with needle roller bearings which run on replaceable hardened steel strips. An electromagnetic brake can be fitted as an additional precaution, but is not considered essential.

New American Designs for Large Nuclear Power Plants

Three new water reactor designs have been developed by the Westinghouse Electric International Company with a view to securing low-cost nuclear power. They are described here by W. L. Budge and J. K. Dillard.

THERE are several variations of water reactor-types. The first of these is the closed cycle or pressurized water reactor. In this system, water under pressure circulates through a primary loop, picking up heat in the reactor and giving it up in a heat exchanger to a secondary system that generates steam. This system has a wide range of application—from 1 to 400 MW. It is the easiest type to control and the most stable that can be built.

The second major division of the natural water systems is the direct cycle type, where steam from the reactor is piped directly to the turbine. In one such reactor, called the direct cycle natural circulation system, the incoming water passes through the reactor core forming a steam-water emulsion. Steam-water separation is accomplished inside the reactor; steam goes on to the turbine, is condensed, and re-enters the reactor. The difference in density between the steam column in the core and the water column outside is sufficient to cause natural circulation in the steam-water loop. This system has excellent application in the small power ranges from 5 to 50 MW. However, because of water flow characteristics and steam separation problems, it takes a very large core to produce sufficient heat.

To overcome this difficulty, we can go to forced circulation of the water. This brings about higher nuclear efficiency and increases the hydraulic stability of the reactor. Capital costs are increased, of course, but the range of this system is pushed up to about 150 MW. In this size plant, the forced circulation system has excellent prospects.

The combination of the direct cycle and closed cycle system is known as the dual cycle. In one leg of the system which is operated as a direct cycle loop, steam is carried directly from the top of the reactor to the turbine and then back to the reactor after it condenses. Meanwhile, a second leg is operating on the closed cycle basis with heat from the reactor being transferred first to a heat exchanger which generates steam for the turbine. In the direct cycle end of this system the steam and water are separated outside the reactor; this steam goes to the high pressure end of the turbine. The lower pressure steam from the closed cycle end enters the turbine in its low pressure range. The power range of the dual cycle plant is from 150 to 300 or 400 MW. This system has higher power density than the other two but also higher capital costs. There's also the problem of possible contamination of the entire primary system including the turbine generator unit. Since it requires a complicated turbine and control system, this system increases in cost to the point where there is little difference between it and a straight closed cycle plant.

For the larger plants it is important to determine which of these two systems has the greater present and long-range potential. To establish this comparison a number of parallel technical and economic studies have been made for closed cycle and dual cycle plants up to 300 MW. The power costs for the closed cycle and dual cycle plants are essentially identical over the range of applicability. The saving in heat exchanger capacity for the dual cycle plant is almost offset by the reduction in piping and other components for the closed cycle plant.

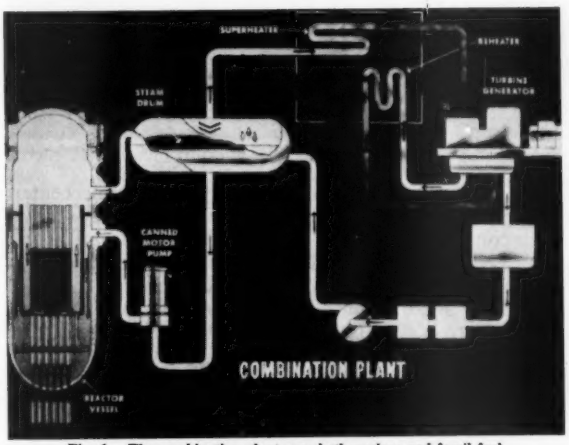


Fig. 1.—The combination plant uses both nuclear and fossil fuel

Where economics are comparable, the choice clearly goes to the closed cycle system. This is dictated by advantages in the important areas of operation and maintenance.

Use of superheat

Of all these major reactor types being considered, the water reactors have the greatest promise of achieving competitive nuclear power the soonest. Here we have not, however, attempted to go into very many of the variations that are being employed to improve efficiencies and reduce generating cost. One of the most important of these variations is the idea of superheating steam as it comes from the reactor to bring it up to modern turbine conditions. Heat rate reductions of 30 to 35% can be obtained by use of high pressure superheat-reheat cycles. Superheating is the next big step and it is a significant part of several specific recommendations made in this article.

Details will now be given of three water reactor plants that hold the most immediate promise for the electric utility industry.

Combination plant

The first one is called the combination plant because it uses both nuclear and fossil fuel. This plant was designed around a modern turbine and the steam conditions it requires. The nuclear reactor and superheat-reheat system was then designed to meet these conditions.

The turbine is rated at 225 gross MW. Steam inlet conditions at the first stage are 1800 psi at 1000°F, with reheat temperatures of 1000°. These steam conditions can be achieved using a direct cycle system.

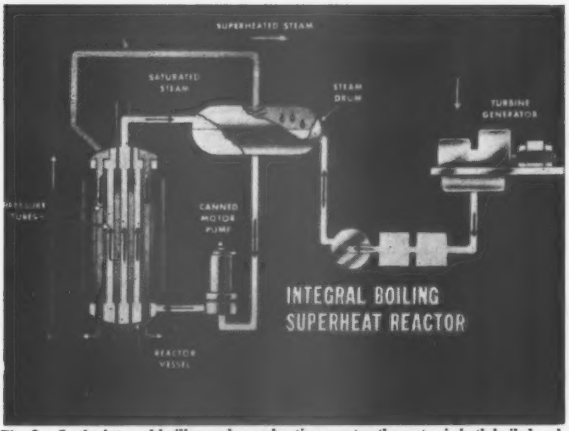


Fig. 2.—In the integral boiling and superheating reactor the water is both boiled and then superheated within the reactor core

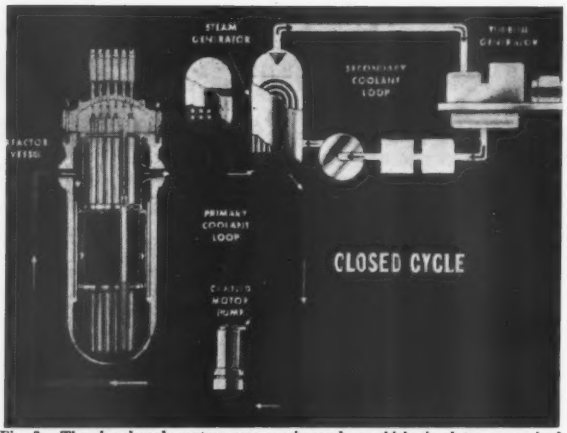


Fig. 3.—The closed cycle system uses a primary loop which circulates pressurized water through the reactor and a heat exchanger, where heat is transferred to a secondary loop, producing steam for the turbine

The next step is superheating to 1000°. A superheater using nuclear fuel could be designed for this purpose, but this second reactor would have a whole new set of problems to be solved and would be prohibitive economically. The most realistic and available solution is to use a fossil-fired superheater. In addition to superheating steam before it goes to the first stage of the turbine, the superheater is used to reheat steam to 1000°F, after it passes through the first section, and before it is fed back into the second section of the turbine.

Fig. 1 shows the general operating principle and main components of the combination plant. In the core of the reactor, water circulates and boils at 2115 psi, dry and saturated. Canned motor pumps circulate the water through the core. A steam separating drum located in the loop between the reactor and the superheater separates water from the steam and ensures that only steam is passed on to the superheater. The water collected at the separating drum is returned to the reactor cycle. The steam from the superheater at 1800 psi and 1000°F passes to the first section of the turbine. After passing through both stages of the turbine, the steam is condensed and returned to the reactor.

The statistics proposed for this plant are as follows: The 34-ft high reactor vessel is 9¼ ft inside diameter, and its walls are of 8-in. thick carbon steel with a ¼ in. stainless steel lining. The core of the reactor is fuelled with about 26½ ton of uranium fabricated into small pellets. This uranium is enriched to about 2%.

The superheater with its auxiliary equipment stands 146 ft high and is 76 by 65 ft rectangular dimensions. This superheater can be fuelled with oil, gas or coal, the choice depending on individual economics.

The nuclear portion of the plant contributes about 300 MW (thermal) and the superheater about 220 MW (thermal) to the net power output of the plant. Together, they would produce an electric gross output of 225 MW. The total heat rate of this plant would be the best yet obtained from a nuclear plant—9040 btu per kWh, net.

As with any open cycle plant, there is the problem of possible oxygen corrosion in the condensing stages of the turbine. But in this plant, studies indicate, because of the high initial reactor pressure and the superheat cycle, the oxygen concentration is only about 1% of that in a 1000 psi dry and saturated steam plant.

Now to economics. The figures are based on 90% load factor; 12·5% annual charges; fossil fuel costs of 30 cents per million btu; and plutonium credit of 12 dollars per gram, and 0·5 mill for indirect costs (a mill is 0·001 dollar).

Under these conditions, the direct cycle nuclear power plant with fossil-fired superheat and reheat will produce electric power for 7·3 mill per kWh. These costs break down as follows: 3·4 mill in capital investment; 2·7 mill for fuel; 0·5 mill for indirect costs, and 0·7 mill for operation and maintenance. The 2·7 mill fuel figure is based on current costs and using 30 cents per million btu oil in the superheater, which is good average. Coal might cost less in itself but the attendant capital investment in rails, storage, ash disposal, etc., would bring the actual cost to about the same figure.

It is important to note that fossil fuel costs affect the total power cost estimates of the combination plant. Naturally, as fossil fuel costs rise, the economical advantage of this plant over totally fossil-fired plants will become less distinct. Specifically, at 40 cents per million btu, power cost on the combination plant will rise to 7·7 mill per kWh; at 60 cents to 8·6 mill per kWh. This may seem at first to be a disadvantage, but compare it to the estimates of the rise in power costs on a completely fossil-fuelled plant. At 30 cents per million Btu the average cost per kilowatt hour is 6·6 mill; at 40 cents, 7·4 mill. But at a fossil fuel cost of 60 cents, the power cost is 9·2 mill, and from then on the gap widens rapidly.

Today, the all fossil-fuelled power plant holds the economy edge over the nuclear plant in all but the highest fuel cost areas. How long it will be until the nuclear plant supplies the least costly power in every area depends on local conditions. In some areas the combination plant will win out on a mills per kilowatt basis *over the lifetime of the plant*. Therefore, until the time when the all-nuclear plant supplies the least costly source of power in every area, there is definitely a place for a combination plant—part nuclear, and part fossil fuelled.

Integral boiling and superheat reactor

The fundamental superheat concept, namely, obtaining more power from each pound of steam, is responsible for the combination plant and leads to our second recommendation—the all-nuclear plant with integral superheating. In this plant, called the integral boiling and superheating reactor, the water is both boiled and then superheated within the reactor core. No separate unit for superheating is required.

The operating principle of such a reactor type is shown in Fig. 2. A number of pressure tubes is inserted into the centre and around the periphery of the reactor, which is essentially a large block of graphite. Rods holding the nuclear fuel are inserted into each pressure tube, and

between these small fuel rods there is enough room for the coolant water to flow. A carbon-steel vessel, through which the pressure tubes extend, surrounds the core.

In operation, circulating water enters the central region boiling tubes and is rapidly heated as it passes through the fuel region. This heated mixture of water and steam moves up to one of four steam drums above the reactor. The separated water is returned to the bottom of the boiling tubes in the central region of the reactor, while the separated steam flows into the upper end of the superheating tubes in the perimeter area of the core. The superheated steam collects in a header and then flows directly to the turbine.

Within the carbon-steel containment vessel, and completely blanketing the graphite moderator in all its vital areas, is helium under a pressure of 100 psi. The helium will control heat transfer from the graphite moderator to the pressure tubes, at the same time maintaining the graphite temperature within safe operational limits. The helium control is necessary since the graphite is hot—in fact, about 10% of the reactor heat generation is performed by the graphite itself.

The integral boiling and superheating reactor offers a very economical, very efficient 200 MW reactor. Here are some of the problems that must be solved:

Control will be a major problem, since within a few inches inside the reactor it will be necessary to have temperature differences of nearly 400°. The answer lies in programming the control rods. The reactor is already designed with a large number of control rods to make this problem easier to solve.

Another aspect of control concerns the flow of the water and steam through the two reactor sections. The two must be balanced, and adjusted to meet the surge demands of the turbine. Fortunately, the pressure-tube design offers a built-in solution. In the superheat section a throttle can be installed at the inlet of each tube, and a thermocouple at the outlet. By coupling these into an information feedback system, precision control of the reactor is possible.

Although not an insurmountable problem, several questions about fuel performance in the higher temperatures of the superheat section need to be answered. Here again, prototype experience is necessary.

Perfectly satisfactory pressure tubes could be made for this reactor, but if they could be made from a stronger metal which does not absorb neutrons excessively, the tube walls could be made thinner. This means more efficiency and lower capital investment. For the superheating region tubes, two alloys, Discaloy and Inconel-X are being examined; for the central boiling region, there are Zircaloy, and AM-350. If one of these alloys proves suitable, substantial reductions in power cost would result.

A suggested prototype plant would be one-tenth the size of the final plant—20 MW. In the prototype, the graphite block is 11 ft dia and 14 ft high. Fifty-six pressure tubes will be located in the centre boiling area, and 24 tubes in the superheat area. Each tube is 2·7 in. dia. Within each pressure tube are 19 fuel rods, each $\frac{1}{2}$ in. and 10 ft long.

The containment vessel is 23 ft high, and 12 ft 6 in. dia, made of carbon steel $\frac{1}{2}$ in. thick. There are two steam drums in the prototype system, each 11 ft long and 4 ft dia. The turbine operates at a steam pressure of 850 psi and 900°F.

330 MW closed cycle plant

The philosophy behind this plant is based on the facts that (a) there is economy in large reactors and (b) the closed cycle plant is the most proved type to date.

The closed cycle system uses both a primary and a secondary loop as shown in Fig. 3. The primary loop circulates pressurized water through the reactor and a heat exchanger. Here the heat is transferred to a secondary loop, producing steam which is piped to the turbine. The condenser and other secondary equipment are all conventional designs.

The reactor vessel itself weighs 300 tons, stands 41 ft high, and is a little less than 12 ft inside diameter. Its walls are carbon steel about 10 in. thick, with an inner cladding of $\frac{1}{4}$ in. stainless steel.

The fuel is in the form of uranium oxide pellets clad in either stainless steel or Zircaloy 2. For more uniform heating and better fuel economy, a novel method has been developed of loading the core in three levels of enrichment. Looking down on the top of the reactor, the fuel elements are loaded into three concentric circles. In the inner circle, the fuel enrichment will be about 2·1%; in the intermediate, 2·6%; and in the outer circle, 2·9%.

Fuel life for this reactor is three full-power cycles. After each cycle the centre circle of fuel is removed. Then the second and third layers of fuel are moved toward the centre, and a new outer layer added of 2·9% enrichment. The uniform heat rate that will result this way will allow the use of fewer control rods, less expensive fuel, and more kilowatts from a given fuel load, all of which mean economy.

After the primary loop water passes through the reactor, it flows to one of the five steam generators. The flow of water through the reactor is 75 million lb per hr. Each steam generator is 45 ft high, and just less than 10 ft inside diameter. The heat exchange tubes within will stand in a plate 23 in. thick, and almost 10 ft wide. No plates of these dimensions have ever been produced, but feasibility studies indicate that it can be done.

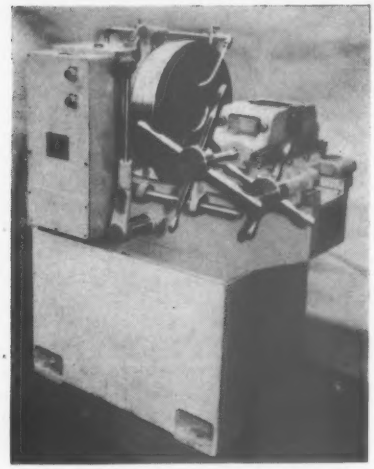
In each of the steam generators, approximately 900,000 lb per hr of dry and saturated steam is produced. All five funnel through a common header into the secondary loop, which feeds steam to the turbine at a rate of nearly $4\frac{1}{2}$ million lb per hr.

The feasibility of a closed cycle plant at every rating from 5 to 400 MW has been studied, and it has been found that power costs reduced sharply in the closed cycle plant until 330 MW is reached, and then there is a sharp levelling of the curve. This levelling reflects an added capital expenditure needed above 330 MW. At that point, the largest single-shaft, 1800-rpm turbine is being used and beyond this point, parallel turbines are necessary.

Further, the economics of the 330 MW turbine are very attractive. It is a highly efficient, 1800-rpm, tandem compound turbine with both a high pressure and low pressure unit. Steam enters the high pressure unit at 650 psi, passes through this first stage and into a moisture separator, and then on to the low pressure section. The first section is designed for double flow, the second for quadruple flow. Operating on a single shaft with 40-in. exhaust blades, the complete turbine-generator set will be 135 ft long

The reactor will be contained in a sphere with an overall diameter of 140 ft and walls $1\frac{1}{4}$ in. thick.

Using the same rules as before, the figures are; for capital expenditure, 3·3 mills per kWh; fuel, 3·0 mills per kWh; operations and maintenance, 0·5 mills per kWh. Including indirect costs of 0·5 mills kWh, the total cost per kWh is 7·3 mills.



The redesigned Heap threading machine has a coolant tank base and a powerful saddle vice

Threading Machine

The 4 in. Type UR and UT threading machines made by Joshua Heap & Co. Limited, Ashton-under-Lyne, have recently been redesigned. A larger cabinet base is now used solely for collecting the cutting swarf and as a tank for the cutting lubricant. The powerful saddle has two pairs of vice jaws for gripping the larger sizes of work and the vice operating screw has been positioned midway between the two pairs of jaws thus eliminating any tendency for the vice to twist when pressure is applied.

The drive to the headstock is from a 3 hp flange mounted motor connected to the driving shaft through a flexible coupling. Pick off gears connecting this and the worm shaft give four spindle speeds, 6, 11, 21, 38 when fitted with a type UR diehead, and 11, 21, 38, 74 when fitted with a type UT diehead. The drive shaft and the worm shaft are mounted on ball bearings.

The electric control gear including the push buttons are built into the headstock of the machine and not only control the main drive motor but also the electric suds pump.

The machine can be fitted with either the UR or UT diehead: in each case the capacity is $\frac{1}{4}$ in. to 4 in. pipes, taper or parallel thread, and $\frac{1}{4}$ in. to 2 in. bolts. The UR diehead is a radial type with a built-in receding mechanism and lever release. It can be opened and closed whilst the machine is running and the receding mechanism enables taper threads to be produced as easily as parallel threads.

The UT diehead is a simple tangential type not fitted with a lever release mechanism: a receding mechanism is incorporated for screwing taper threads.

Tapping equipment, die grinding fixtures and roller steadies, etc., are available for these machines.

Sunnen Honing Machine

The Sunnen honing machines which as reported recently in our "Business & Professional" section, is marketed in U.K. by Thomas Mercer Limited, St. Albans, is based on a geometric principle involving the unequal spacing of three bearing surfaces. Two rigid metal guide shoes locate the component and a third surface, a precision graded abrasive stone, contacts the surface of the bore under constant and controlled pressure. The unequal spacing of the surfaces cannot generate, nor will they follow, an out-of-round pattern, and the long guide shoes bridge any bow or other irregularity in the bore, thus maintaining a true axis.

The honing stones are precision graded to the highest standards of the abrasive industry; they cut cleanly and freely, and their performance from component to component is consistent. Any given grade of stone will consistently produce a pre-determined micro-finish in a given material, so closely are the stones graded.

The capacity of the machine is 0·100 in. dia bore to $2\frac{5}{8}$ in. Mandrels and stones are available for bores up to 18 in. long, for blind bores, through bores, keywayed bores and for some splined bores. This system of producing accurate holes is particularly applicable to hydraulic sleeves, where the bore is broken by a number of ports as there is no "wash away" where the port meets the bore, and also where "tandem" bores have to be produced with high in-line accuracy. An attachment is used for producing similar accuracy and finish on diameters.

There are three variations on the basic machine, the pedestal machine priced at £389, the bench machine with ball-bearing spindle and run-out adjustment £270 14s. 6d., and the same but without ball-bearing spindle and run-out adjustment, £245 13s. 0d.

Lumsden Surface Grinder with Automatic Feed Control

The latest addition to the Lumsden range of grinding machines is the 90ML which incorporates a new automatic feed control to the wheel spindle ram. With this mechanism it is now possible to preset accurately the amount of stock to be removed. For example if 0·050 in. is to be removed and the estimated ratio of stock removal to wheel wear is 10:1, the trip dial is set to 50+5, i.e. 55, and the feed rate adjuster set to any one of 10 feeds according to surface area and material to be ground. The trip dial turns as the wheel descends so that it shows the amount the wheel still has to feed. The feed stops when the trip dial registers zero. A second dial is provided for setting and adjusting the

The new 90ML Lumsden surface grinding machine and (below) the trip dial of the new automatic feed control

trip mechanism, this dial is graduated in very widely spaced 0·001 in. divisions.

Another development on this machine is a new safety device which ensures that should the current to the magnetic table fail, a relay starts the elevating motor of the wheel spindle ram in the upward direction and all other motors stop. Thus the wheel is clear of the work before the residual magnetism has decreased sufficiently to allow the work to be thrown off the table as it slows to a stop.

Other electrical interlocks are provided to ensure safety of operation. For example, the feed handwheel must be pulled outwards before the feed motor can be started—this ensures that there is no danger of a blow from the spokes of the handwheel and that the "Down" button is inoperative, should this be pressed instead of the "Feed Start". Another interlock ensures that the magnetic table must be energized before the spindle motor can be started. The sole agents for the Lumsden range of surface and tool grinding machines are Alfred Herbert Limited, Coventry.

Multiple Pitch Automatic Lead Screw Tapping Machines

Compact, highly sensitive, high speed tapping machines have been developed specially for through or blind hole tapping requiring high accuracy by Milman Engineering Company, Los Angeles, U.S.A., for whom the sole selling agents in the United Kingdom are Rockwell Machine Tool Company Limited, Welsh Harp, Edgware Road, London NW2.

Using one hardened and ground master leadscrew, these machines will tap all commonly used BA threads and BSF threads up to $\frac{3}{16}$ in. Other pitches provided by the standard change gears are 32, 36, 40, 44, 48, 56, 64, 72, 80 and 96 T.P.I. Special gears are available for 90, 120 and 200 T.P.I.

The tapping head is built into an aluminium casting fitted with an easily removable cover. Two external surfaces of the head casting are machined square and parallel to the spindle for use in setting the head in positions other than the normal vertical. The complete head unit is adjustable for height on its tubular column and the cast iron base has a precision ground 10 in. × $6\frac{3}{4}$ in. working surface for the accurate location of work or fixtures.

The spindle is powered by a $\frac{1}{4}$ hp series wound instantaneously reversible motor, the drive being transmitted to an adjustable friction clutch through a 5:1 timing belt reduction.

The feed rate of the tapping spindle is changed by altering the relative rates of rotation of the master leadscrew and its matching nut. This is achieved by cluster gears and two change gears. Changeover from one pitch to another is quick and simple as it is only necessary to fit the appropriate pair of change gears and place the cluster gear in one of three positions.

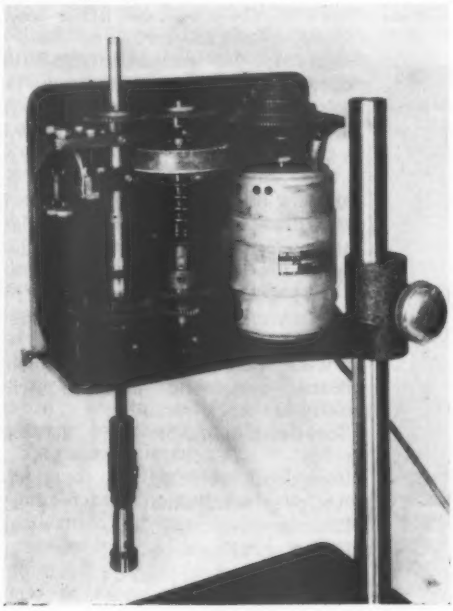
Spindle stroke is adjustable from $\frac{1}{8}$ in. to 2 in. and is governed by limit switches which can be set to use any portion of this range anywhere along the length of total adjustment. Mechanical safety features prevent damage in the event of failure of either of these switches.

Spindle speed is infinitely variable and depending upon the spindle stroke, thread and material being tapped the machine will operate at up to 3,000 cycles per hour.

Control is by two foot switches or by two push buttons on the control box. The "down" switch initiates the tapping cycle, the spindle reversing automatically at the preset point, returning to the upper position and braking. It is emphasized that it is only necessary to "pulse" the controls and not keep them depressed.

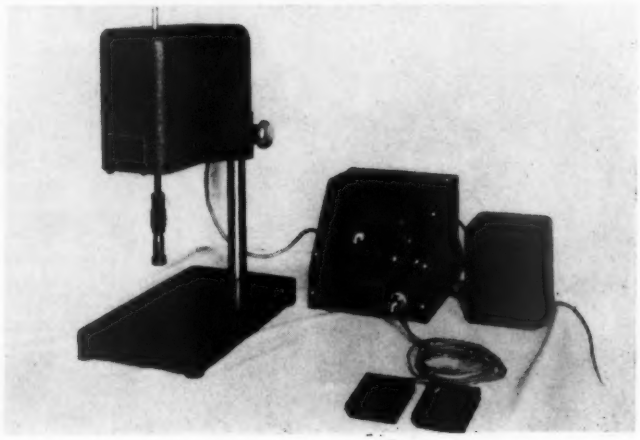
Should the progress of the tap be arrested, e.g. by hard spots in the material, the spindle can be immediately reversed by operating the "up" switch. Tap breakages are thus reduced to a minimum.

A Jacobs "Rubberflex" collet chuck is fitted to the spindle and this accepts taps for all threads within the capacity of the machine.

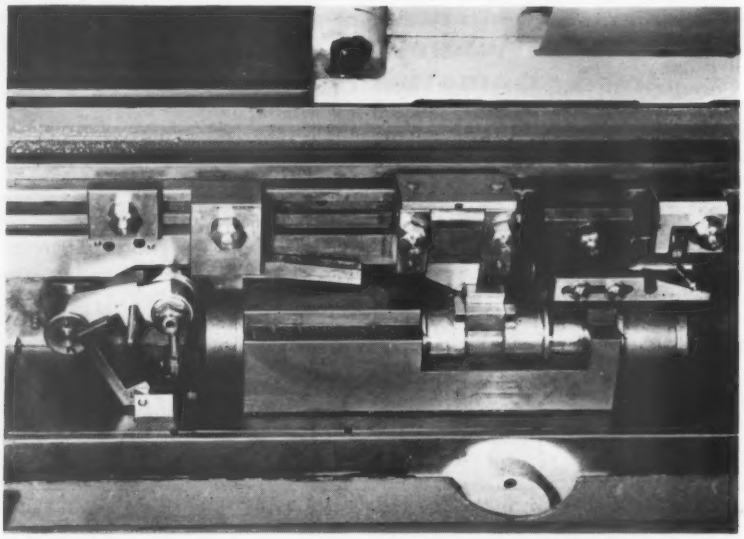


Cluster gears and two change gears are used to control the rotation of the nut on the master lead screw of the Milman tapping machine at left

Control is by buttons on the control box or by foot switches (below)



Close-up of the hydraulically operated two stage gauging mechanism



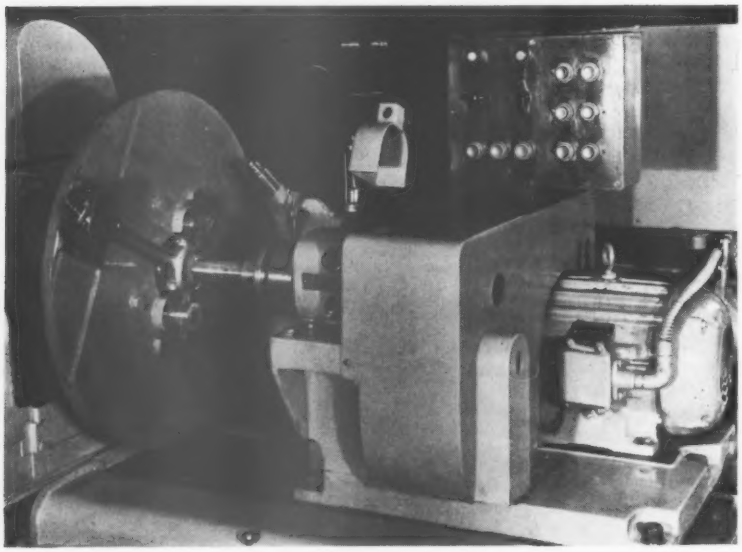
Arrangement of dogs and adjustable cam for control of the table stroke

Grinding Con-rod Bores Automatically

An automatic machine for grinding connecting rod big end bushes has recently been developed by Keighley Grinders Limited, one of the Newall Group of Companies, of Peterborough. Fundamentally the machine is designed for grinding holes from ¼ in. to 6 in. dia, and for connecting rod work the conventional drawbar chuck is replaced by a special workholding fixture designed to ensure parallelism between small and big end bores. The machine has both gauge and diamond sizing mechanisms, d.c. injection brake and hydraulic fixture operating gear.

After initial setting up, the machine is controlled by manipulation of a single lever. Application of this lever causes the worktable to advance at rapid traverse speed until the grinding wheel enters the bore when the rate is reduced to grinding speed and the table reciprocates on a stroke adequate to cover the entire length of the bore. At this stage roughing feed begins and continues until a pre-determined size is reached and the gauging member controlling rough grinding size is able to enter the bore.

Detail of the workholding fixture. Photograph also depicts the wheelhead, dresser and electrical control panel



Continuing the automatic cycle, the wheel is backed off, then retracts from the bore and table speed is reduced for dressing immediately the rear edge of the grinding wheel approaches the diamond position. To ensure that the wheel is fully trued, dressing takes place during both outward and inward strokes; on completion of dressing the diamond withdraws, the wheel re-enters the workpiece and regains contact with the bore.

Table reciprocation at a lower speed continues and fine feed is engaged, the gauge entering the bore as finish size is achieved. The gauge is then automatically withdrawn, the wheel backs off and leaves the bore, the feed dial retracts and the table returns to the loading position. Wheel wear compensation automatically takes place at the termination of each grinding cycle.

The following figures relate to production times maintained under normal working conditions:

Time per piece for components bored concentric and requiring 0·014 in. stock removal:

Bore finish diameter ...	2·394 in. to 2·3945 in.
Bore depth	1·515 in.
Rough grinding time ...	15 sec
Dressing time	7 sec
Finish grinding time ...	7 sec
Loading and unloading time	25 sec

Random Vibration. Edited by Stephen H. Crandall. London, 1960; Chapman & Hall Limited (jointly with The Massachusetts Institute of Technology and John Wiley & Sons Inc., New York). 68/- net (by post 69/6). 423 pp. $5\frac{3}{4} \times 9$ in.

Random vibrations are encountered in the meshing of imperfect gears, in the rolling of imperfect components, in turbulent flow, and more acutely in and around jet engines and rocket motors. Apart from the noise the important practical problems are machine damping and metal fatigue.

The eleven contributions to various aspects of the subject contained in this book were originally prepared for a summer programme at the Massachusetts Institute of Technology in 1958. Professor S. H. Crandall opens the book with a review of the classical analysis of linear vibratory systems as a foundation for the subsequent treatment of random vibration. Associate Professor W. M. Siebert describes random processes and H. Poritsky deals with stochastic processes of mechanical origin. The response of linear systems to random excitation is treated by Professor S. H. Crandall who obtains some of the statistical features of the response by using the assumption that the excitation is a stationary ergodic random process with a Gaussian probability distribution. Associate Professor T. H. H. Pian discusses structural damping and Professor F. A. McClintock the general subject of fatigue of metals. Up to this point the authors have been concerned in providing a foundation for the more specific treatment which follows, commencing with instrumentation for random vibration analysis (Assistant Professor T. P. Rona), the response of structures to random pressures and to jet noise in particular (Associate Professor A. Powell), the estimation of sound-induced missile vibration (I. Dyer), the basis for the design of simulation equipment (K. J. Metzgar), the technical characteristics of simulation equipment (D. E. Priest), mechanical design for random loading (R. M. Mains), and the minimizing of damage from random damage, by the same author.

Engineers already well versed in the study and treatment of mechanical vibration will find that this book provides them with the new concepts required to extend ordinary vibration theory into the field of random vibration, and also some idea of the current state of the art of designing and testing equipment which must withstand random vibration.

Small Gas Turbines and Free Piston Engines. By Arthur W. Judge. London, 1960; Chapman & Hall Limited. 48/- net (by post 49/2). 328 pp. $5\frac{1}{4} \times 8\frac{1}{2}$ in.

The gas turbine suffered from certain disadvantages in its early days, notably on the score of lack of economy, but it was predicted that these would be overcome in time. If any sign were needed that this stage is being reached or is imminent it is the advent of a number of commercially produced small gas turbines. In fact some turbines now have a better fuel consumption than the average

books

petrol engine. The smallest, however, have not yet reached this stage, for not all the refinements of larger installations are economically feasible with small machines.

The small machines are finding applications for pumping and similar duties as well as in aircraft and for boat propulsion, and while their use in cars is still experimental, the work of investigation continues to arouse active interest. In this book Mr. Judge discusses every aspect of the subject, both theoretical and practical, and deals also with the free-piston engine and with the special constructional materials which alone make possible the manufacture of reliable machines. A number of turbines are described, and illustrated with photographs and sectional drawings.

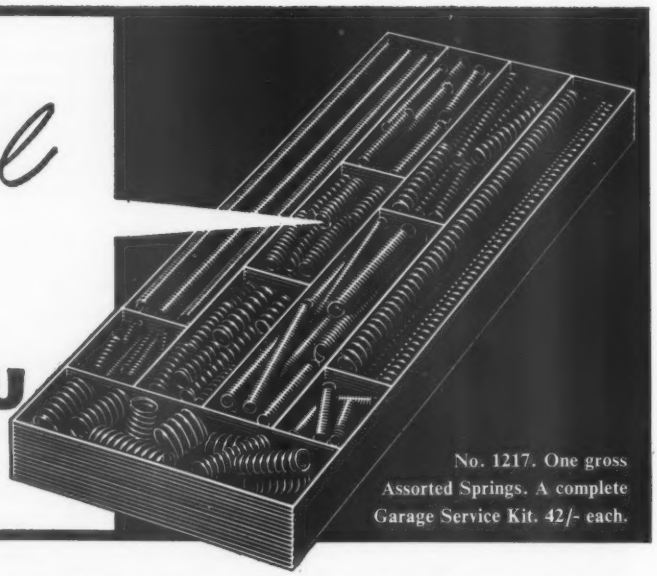
Applied Petroleum Reservoir Engineering. By B. C. Craft and M. F. Hawkins. London, 1960; Constable & Co. Limited. 62/6 net (by post 64/-). 437 pp. 6×9 in.

Petroleum reservoir engineering is concerned with the study of subterranean deposits of petroleum, whether gas or oil, and the water that either accompanies or replaces them. In its modern well-developed form it provides accurate information of the extent and nature of the deposits and the course during the life of an oilfield. The present book treats the subject exhaustively, requiring an engineering or geological background as a start and taking the reader right through to the present highly developed level of "reservoir" engineering practice. It opens with a history of the subject and rates the various physical principles applied in the study and then goes on to deal with the different types of natural petroleum reservoirs—the gas, gas-condensate, undersaturated oil types and those under simultaneous dissolved gas drive, gas cap drive, and water drive. Water influx is accorded separate study, as also are the subjects of fluid flow in natural reservoirs and the displacement of oil and gas.

Technical Know-How.—The European Productivity Agency, through its monthly publication—*European Technical Digest*, provides a service at the disposal of industry in all countries and all continents. The purpose is to spread from one country to another, irrespective of language barriers, technical information and knowledge likely to increase productivity, and to cross-feed ideas from one industry to another. Although the digests cover such sectors as glass, chemicals, leather, textiles and timber, they deal principally with all kinds of engineering and equipment, metallurgy and agricultural machinery, and importance is attached to subjects of general interest, such as corrosion, materials handling, packaging, safety and management. Apart from the English edition, the publication now appears in German, Italian, Norwegian, Spanish, Turkish, Croat and Japanese and, on a selective basis, in Hebrew and Icelandic. Greece and the Netherlands produce translated title lists. The yearly subscription is £3. 10s. from European Productivity Agency, Organization for European Economic Co-operation, 2, Rue André-Pascal, Paris.

"The Ironfoundry Handbook".—This new reference book for the ironfoundry trade contains information which will assist designers and manufacturers using castings in their work, notably by providing a guide to the facilities, capabilities and capacities of individual foundries, enabling users

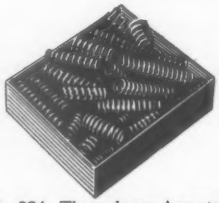
THAT *Experimental Spring* YOU WANT IS WAITING FOR YOU IN THIS BOX...



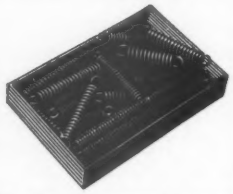
No. 1217. One gross Assorted Springs. A complete Garage Service Kit. 42/- each.

If not, try another box in the Terry Assorted Springs range

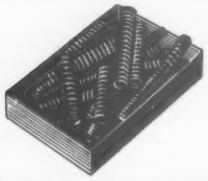
No. 1200. Three dozen Assorted Light Expansion Springs, suitable for carburettor control, etc. **13/6.**



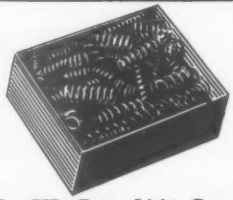
No. 98A. Three dozen Assorted 1" to 4" long, ¼" to ¾" diam., 19G to 15G. **5/6.**



No. 753. Three dozen Assorted Light Expansion ¼" to ½" diam., 2" to 6" long, 22 to 18 S.W.G. **10/6.**



No. 760. Three dozen Assorted Light Compression Springs. 1" to 4" long, 22 to 18 S.W.G., ¼" to ½" diam. **6/6.**



No. 757. Extra Light Compression, 1 gross Assorted, ⅛" to ⅜" diam., ½" to 2½" long, 27 to 19 S.W.G. **15/-.**

No. 758. Fine Expansion Springs. 1 gross Assorted ¼" to ⅜" diam., ½" to 2" long, 27 to 20 S.W.G. **15/-.**

We know *exactly* how difficult it is to find springs for experimental work . . . we've been making quality springs for over 100 years. So, we confidently offer you our excellent range of small boxed assortments which covers a very wide range.
We can only show a *few* boxes. Send us a p.c. for our full list.
If ever you are stuck with a spring problem let our Research Department put their long experience at your disposal.

Have you a Presswork problem?

If so, the help of our Design Staff is yours for the asking.

TERRY'S *for SPRINGS*

Really interested in Springs? "Spring Design and Calculations" 9th Edition tells all—post free 12/6.

Cut Production Costs with Terry's Wire CIRCLIPS. We can supply immediately from stock—from ⅛" to ½".

Looking for good Hose Clips? Send for a sample of Terry's Security Worm Drive Hose Clip and price list.

HERBERT TERRY & SONS LTD

Redditch, Worcs.

(*Makers of Quality Springs, Wireforms and Presswork for over 100 years*)

HT30

to contact a suitable foundry for specific types of work, and also a buyers' guide to all kinds of foundry equipment and materials. The price of the book is 42/- for a single copy and 35/- each for two or more. The book, which will appear in a new edition every two years, is published by The Standard Catalogue Company Limited, 26 Bloomsbury Way, Holborn, London WC1.

Basic Theorems in Matrix Theory.—A publication of this title by M. Marcus, issued by the National Bureau of Standards as Applied Mathematics Series 57 (order from Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C., price 19 cents), is a survey of the basic identities and inequalities of matrix theory, and is intended as a handy reference for research workers and students. Included are results dealing with elementary properties, canonical forms, invariance, congruence, commutativity, orthogonalization, eigenvalues, determinants, submatrices, rank, determinant and rank inequalities, numerical methods for inversion and eigenvalues, and condition numbers. No attempt has been made to provide proofs for the theorems listed; and all statements are made directly in terms of matrices rather than linear transformations. References are given after each result, unless the result is found in most textbooks on matrices.

Engineering in Europe.—Although the rate of deliveries from the engineering industries fluctuates from year to year, there is nevertheless a continuing increase. Prices show an upward trend also. Efforts continue to increase also but apparently at the expense of some internal demand. Extensive statistics on these matters are given in a new O.E.E.C. publication "The Engineering Industries in Europe." It is obtainable from H.M. Stationery Office, price 7/6 net.

Hydro-electric Construction Bibliography.—The second volume (Vol. I appeared in 1957) of "Biographical Index of Works Published on Hydro-electric Plant Construction" has been published at Geneva by United Nations and is available from H.M. Stationery Office, price 2/6. It incorporates additional information communicated by Belgium, Italy, Switzerland and the U.S.S.R. English translations of titles are given.

Russian Engineering Journal.—The Production Engineering Research Association, Melton Mowbray, Leicestershire, are producing each month a cover-to-cover translation into English of the "Russian Engineering Journal." In the current issue (No. 6, 1959) the articles are grouped principally under Machine Design, Machine Construction Technology, and Production Management and Economy. The U.K. price of a single copy is 16/-.

Russian Patents and Inventions.—The first issue of the complete translation into English of the Russian journal of the above title has been issued by Pergamon Press Limited, 4 & 5 Fitzroy Square, London W1. The annual subscription for the complete volume is £50, and £10 or £15 for single sections (there are 17 sections).

New Standards

Mineral-insulated cables. Part 1: Copper-sheathed cables with conductors (B.S. 3207: Part 1: 1960) Price 5/-.

Mineral-insulated cables were standardized dimensionally in the 1949 edition of B.S. 883, 'Cables and flexible cords for electrical equipment of ships', but this new publication is the first British Standard to give a complete specification for such cables, with tests. The dimensions are the same as those given in B.S. 883: 1949, but they are no longer related to drill sizes and are now stated as standard values with positive and negative tolerances. In the new standard the cables formerly known as 250-volt cables are classified as 440-volt cables. The 660-volt classification remains unchanged. Both classes are suitable for use at the stated voltage between conductors or between conductors and sheath.

The cables covered by the first part of the new standard have copper conductors and copper sheath, with provision for an outer PVC covering when required. It is hoped to publish eventually additional parts dealing with other conductor materials and different types of sheath.

Speedometers and Odometers for Road Vehicles (B.S. 3190: 1960). Price 6/-.

The ever-changing variety of motor-cars and light vans made the standardization of their speedometers and odometers difficult, and consequently Part 1 of this standard is somewhat restricted. It does, however, cover the drive, accuracy, protection, installation and general performance of these instruments for this type of vehicle, and there is a section on tests. Part 2 deals with speedometers and odometers for heavy commercial vehicles, and in this field it was possible to lay down more comprehensive requirements and to achieve greater standardization. Drive, installation, types of enclosure, mounting and overall dimensions, parallax, dial presentation, rotation and deflexion, insulation resistance, accuracy, performance in different conditions of temperature and humidity, index stability and identification marking are all dealt with, together with type and routine tests.

Enamelled copper conductors (self-fluxing, enamel with polyurethane base). Part 1: Round wire. B.S. 3188. Price 7/6.

Enamelled wire with self-fluxing properties has become an established product in the electrical industry. The requirements of this new standard are generally similar to those of B.S. 1844 and B.S. 3160, which deal with other kinds of enamelled wire, but there is in addition a solder test to ensure that the self-fluxing properties are adequate. 'Fine' and 'medium' coverings are specified over a range of wire sizes from 0·0016 in. to 0·064 in. diameter.

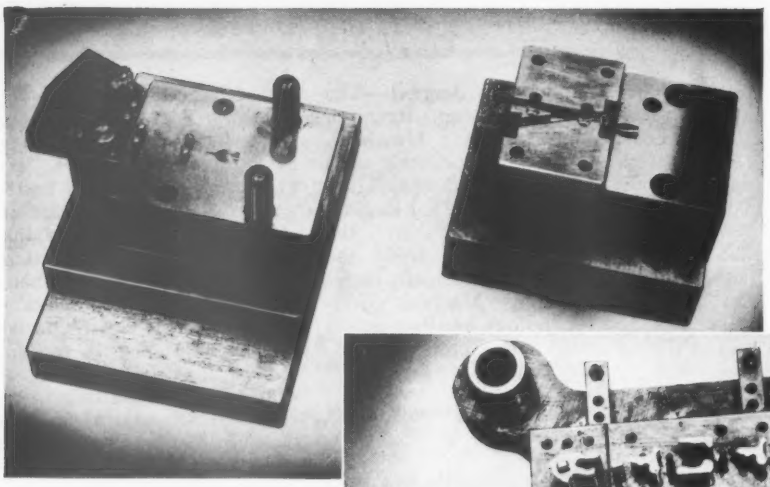
Impregnated-asbestos-covered copper conductors. Part 3: Round wire—metric units. B.S.1497. Price 4/6.

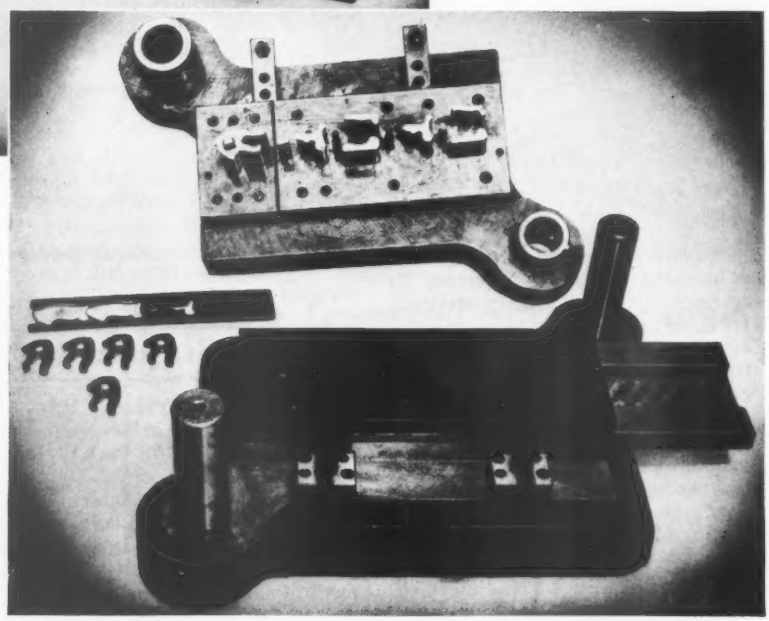
This publication is an addition to the series of metric versions of standards for covered winding wires. The requirements are essentially the same as those of B.S. 1497: Part 1, but metric measure is used throughout and a complete range of standard metric sizes is given.

Translations of German Industrial Standards

The German Standards Committee (Deutscher Normenausschuss), Berlin W15, has set up a department to prepare translations of German industrial standards in English. So far, 820 English translations have been made. New lists of the translations available may be obtained free of charge from the Beuth-Vertrieb GmbH, Berlin W15, Uhlandstr. 175.

British Standards Institution, 2 Park Street, London, W1.





4 times as much with DOUBLE SIX!

EDGAR ALLEN

DOUBLE SIX DIE STEEL

Steel hardened at 60 C Rockwell for anvil dies working at 3000 blows per minute, pressing tapers on parallel collets for working stainless steel wire, was found to give only about 2 hour's life, but when Double Six die steel was used, longer life was found than the user aimed for.

Double Six is like that: just one of the many die steels we produce for applications from blanking and tin-making to mandrels, ring gauges, etc.

Post the request form for further details.

To Edgar Allen & Co. Ltd., Sheffield 9.
Please post Die Steels booklet to:

Name .....

Firm .....

Address .....

..... 57 M.W.

EDGAR ALLEN & CO. LIMITED
IMPERIAL STEEL WORKS · SHEFFIELD 9

TELEPHONE: SHEFFIELD 41054 TELEGRAMS: ALLEN, SHEFFIELD TELEX

BUSINESS & PROFESSIONAL

Personal

Mr. J. Mackenzie-Mair has been appointed to the board of Steel, Peech and Tozer, a branch of The United Steel Companies, Limited, and assumes the title of director and commercial manager. **Mr. M. Thomas** has been appointed assistant works manager (services) and **Mr. E. Houghton** has become assistant works manager (special duties). **Mr. D. R. B. Burdass** is now personal assistant to the general works manager. **Mr. D. Reilly** has joined the company as cold rolling mill manager. Until recently he was with Guest, Keen and Nettlefolds, Limited, and will be responsible in his new capacity to the works manager, Ickles, for both the existing and new cold rolling departments. **Mr. G. D. Jordan,** who has been senior engineer in United Steel's department of operational research and cybernetics since its formation, is now Templeborough melting shop project secretary, responsible to the chief engineer. **Mr. J. Hewitt,** of the research and development department of United Steel, has been appointed senior research metallurgist responsible to Dr. B. B. Hundy, chief research metallurgist. **Mr. J. Ravenscroft,** until recently employed by the British Iron and Steel Research Association, has joined the company as arc furnace research assistant, responsible to Mr. R. S. Howes manager of the Rotherham melting shop.

THE Surform division of Firth Cleveland Tools Limited, a member of the Firth Cleveland Group, has appointed **Mr. N. Withers** as Surform industrial representative.

CAUSEWAY REINFORCEMENT LIMITED, Northfleet, Kent (a member of the Amber Group of Companies) have appointed **Mr. T. C. Leach** to be their representative in the five Midland counties for their Surface armouring and multi-purpose trestles. **Mr. C. T. Withy** has been appointed representative in Lancashire and Yorkshire.

A trestle sales division has been created under **Mr. S. J. Davies.**

Mr. F. G. Pentecost, chairman of A. Boake, Roberts & Co. (Holding) Limited, has been appointed a director of Albright & Wilson Limited.

ASSOCIATED ELECTRICAL INDUSTRIES LIMITED announce that **Mr. L. C. Richards,** until recently chief engineer of their transformer division at Manchester, has become chief engineer to Heavy Electricals Limited, India. He is seconded to this position from A.E.I. Overseas Limited, to whom he has been transferred. **Mr. C. K. White** has been appointed chief estimator, Estimating Department, A.E.I. (Rugby) Limited, in succession to **Mr. A. T. Gaiger** who recently retired. **Mr. O. T. Evans, Assoc.M.C.T., A.M.I.Mech.E., M.I.E.E.,** has been appointed manager of the new Plant Applications Engineering Department of A.E.I. Heavy Plant Division, with headquarters at Rugby. He was formerly at Manchester. **Mr. W. Spence** is deputy manager. **Mr. J. N. M. Legate, B.Sc., A.M.I.E.E.,** has been appointed manager, Control Gear Engineering Department (Manchester), of A.E.I. Motor and Control Gear Division, and **Mr. C. T. Scarf** has been appointed chief control gear development engineer. **Mr. E. M. Whitaker, B.Sc., A.M.I.E.E.,** has joined Associated Electrical Industries (Woolwich) Limited, as assistant to the commercial director, Mr. J. W. Ridgeway.

Mr. R. N. Millar, M.A.(Cantab), B.Com., M.I.Mech.E., M.I.E.E., a director of The General Electric Company Limited, has been appointed managing director of the company's engineering group which has its main works at Erith, Kent, and Witton, Birmingham. As a consequence three new appointments have been made at the company's engineering works at Erith. They are: **Dr. K. J. Wootton,** general manager of Erith Works and **Mr. C. J. O. Garrard,** deputy general manager; **Dr. H. K. Cameron,** manager, Atomic Energy Division, Erith.

THE PLESSEY COMPANY LIMITED announce that **Brigadier J. D. Haigh, O.B.E., M.A., M.I.E.E.,** has been appointed divisional manager of their capacitors and resistors division, Swindon. **Mr. K. R. Sandiford, B.Sc.(Eng.),** has joined Hagan Controls Limited, one of the Plessey group of companies as general manager.

Mr. Barrie Heath, D.F.C., M.A., managing director of Powell Duffryn Carbon Products Limited and a director of other companies in the Powell Duffryn Group, has relinquished his Powell Duffryn appointments to take up another appointment. As a consequence **Mr. R. Turner, M.I.Mech.E.,** acting managing director of Powell Duffryn Technical Services Limited, has joined the board of Powell Duffryn Carbon Products Limited as deputy chairman, and **Mr. F. W. Stokes,** a director and the present works manager of the company's factory at Hayes, has been appointed general manager.

BRITISH INSULATED CALLENDER'S CABLES Limited announce the appointment of **Mr. K. A. Fillmore** as divisional sales manager, Leigh Works. Mr. Fillmore succeeds **Mr. D. I. S. Hinton** who is taking up an appointment with BICC-Burndy Limited.

CHASESIDE ENGINEERING COMPANY LIMITED announce the appointment of **Mr. S. J. Burton** as export sales manager.

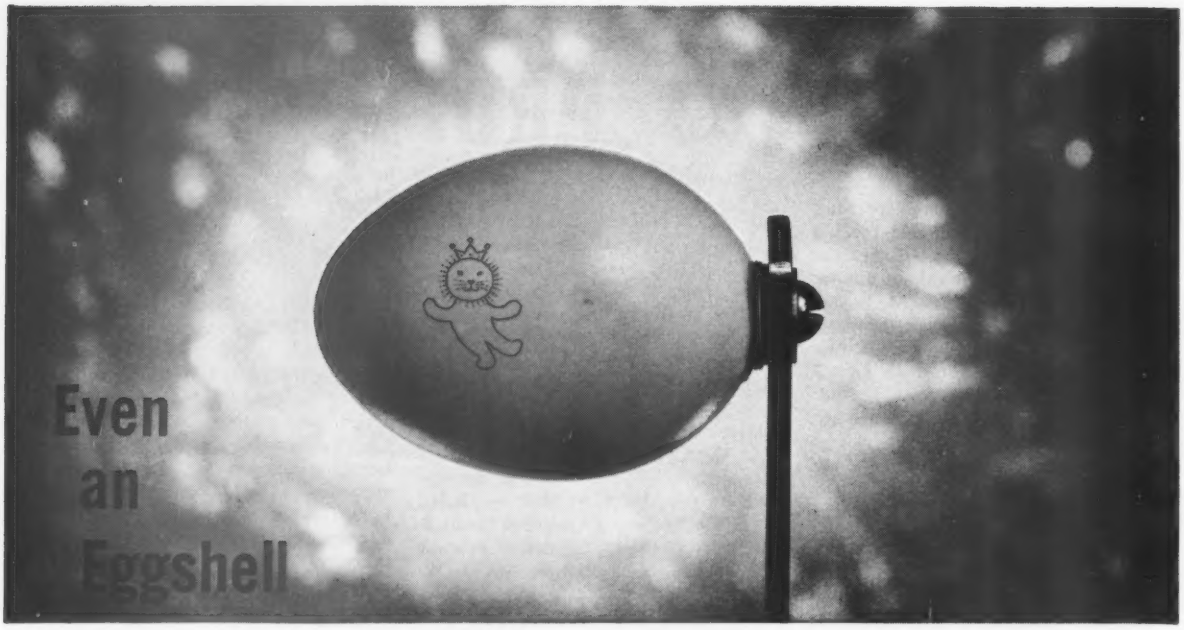
THE FAIREY COMPANY LIMITED have announced the following new appointments and changes to the board of directors: **Mr. Geoffrey W. Hall** continues as chairman of the company but relinquishes his appointment as managing director; **Mr. C. H. Chichester Smith** is appointed managing director; **Mr. C. C. Vinson** is appointed an additional director; **Mr. L. S. Dawkins** is appointed an additional director, retaining his appointment as secretary.

F'AG BEARING COMPANY LIMITED of Wolverhampton U.K. sales organization of Kugelfischer Georg Schafer & Co. Schweinfurt, Western Germany announce the appointment of **Mr. J. W. H. Nicholson** as advertising and publicity manager.

FOLLOWING the acquisition by Metal Industries Limited of Lancashire Dynamo Holdings Limited the following board changes are announced: **Sir Charles Westlake,** the chairman, and **Mr. John Black,** the deputy chairman of Metal Industries, have been appointed chairman and deputy chairman respectively of Lancashire Dynamo Holdings from which company **Lt. Col. G. S. Marston** has resigned as chairman, managing director and director. **The Earl of Halsbury** retains his office as vice-chairman. **Mr. Wilfred Padley, C.M.G., O.B.E.,** has been appointed to the board of Metal Industries Limited. He has been succeeded as managing director of Brookhirst Igranic by **Mr. A. B. Vickery, O.B.E.**

Mr. C. E. Hollinghurst, M.Eng., A.M.I.C.E., has been appointed a deputy chief engineer (Civil) on the highways engineering staff of the Ministry of Transport at headquarters. He is succeeded as divisional road engineer, Metropolitan Division, by **Mr. J. A. S. Dakers, B.Sc., A.M.I.C.E. Mr. H. S. Keep, M.C., B.Sc.(Eng.), A.C.G.I., M.I.C.E.,** is leaving South Eastern Division to take up a new post as an assistant chief engineer at headquarters. He is succeeded as divisional road engineer, South-Eastern Division, by **Mr. T. E. Hutton, B.Sc.(Hons.), M.I.C.E., A.M.I.Mun.E. Mr. L. P. F. Hubbard, B.Sc., A.M.I.C.E., A.M.I.Mun.E.,** has been appointed divisional road engineer, South Western Division, in succession to Mr. Hutton.

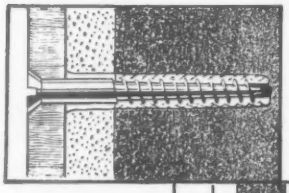
Mr. W. F. List, assistant managing director of C. C. Wakefield & Co. Limited and of Wakefield-Dick Industrial Oils Limited



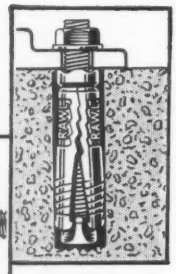
can be Screw-fixed with a RAWLPLUG FIXING DEVICE!

If you live to a hundred, you are unlikely to want to do much screw-fixing of eggshells! Yet this feat—possible only with a Rawlplug Fixing Device (a Rawlnut)—does serve to highlight the astonishing effectiveness of these Devices in making 'difficult' and even 'impossible' fixings simple and straightforward. Whatever the screw or bolt fixing job, you'll save time, money and temper by using the appropriate Rawlplug Fixing Device.

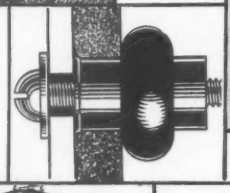
RAWLPLUGS
The famous Rawlplug makes firm screw fixings in masonry in a mere fraction of the time taken by any other method. For all screw sizes up to ⅜" diam. coach screws.



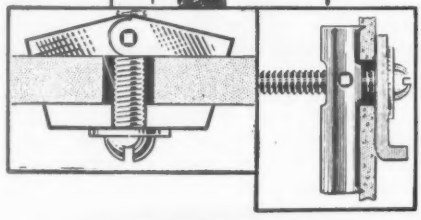
RAWLBOLTS
For light or heavy bolting jobs. A dry fixing of enormous strength—no cold chiselling, no waiting for cement to harden. In all bolt diameters up to 1".



RAWLNUTS
The amazing Rawlnut forms its own 'rivet head' behind the material when screwed up from the front. Shakeproof and waterproof, it has many valuable uses in both building and manufacture.

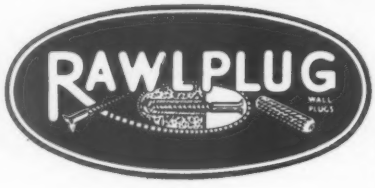


SPRING TOGGLES
For making firm fixings to such thin and structurally weak materials as plasterboard, ceilings, etc. The wings of the device spring apart behind the material and spread the load over a wide area.



GRAVITY TOGGLES
Passed through a hole in hollow material, the long member falls into a vertical position by gravity, and is then drawn against the back of the material by screwing from the front.

IMPOSSIBLE FIXINGS ARE EASY WITH



FIXING DEVICES *For Speed and Strength!*

The World's largest manufacturers of fixing devices

THE RAWLPLUG COMPANY LTD., CROMWELL RD., LONDON S.W.7

B669

has completed 50 years with the Wakefield Castrol Group.

Mr. James Robertson is to be released from his executive position as chief production engineer of Simms Motor Units Limited to become special technical assistant to the managing director.

Mr. A. J. Wilson has joined the board of directors of Charlton Weddle & Co. Limited, Newcastle upon Tyne. In addition to controlling the home and overseas sales of the company's products he will be responsible for the commercial development of the new "ANFO" controlled system of anti-fouling, and the H. E. heating coil system. Mr. Wilson will continue as managing director of Wilson, Taylor & Co. Limited, cathodic protection engineers of 4, New London Street, London EC3, and Charlton Weddle & Co. Limited, will also establish their London office at this address.

THE OWEN ORGANIZATION announce that **Mr. E. J. Boag,** previously works manager of the Phosphor Bronze Company Limited, has now been appointed director and general manager of C. & L. Hill Limited, Stringes Lane, Willenhall, Staffs, and its subsidiaries. **Mr. W. A. Bannister** becomes sales director and **Mr. L. E. Morris** continues as works director. A new department in the motor division of Rubery, Owen & Co. Limited, Darlaston, South Staffs., to be called the trailer equipment department has been formed under the joint management of **Mr. J. T. Pierce** and **Mr. E. Pike.**

KERRY'S (GREAT BRITAIN) LIMITED announce that **Mr. C. Longden,** previously depot manager at Sheffield, is now district manager at Middlesbrough. **Mr. B. Skelton,** formerly depot manager at Cambridge becomes depot manager at Sheffield. **Mr. A. T. Francis,** formerly at Perivale Depot, is now depot manager at Cambridge.

Mr. A. J. Ingram has taken up an appointment on the outside sales advisory staff of Blackstone & Co. Limited, Dursley and Stamford.

Mr. Joseph Samuels, who, as a member of the board of Winston Electronics Limited, Shepperton, Middlesex, has been purchasing director for several years, has now been appointed works director in charge of production.

Mr. James Baxter has been appointed field sales manager for the Scottish branch of Griffin and George Limited, Ealing Road, Alperton, Middlesex.

Mr. W. H. Haugh has been appointed manager of the Glasgow branch office of Renold Chains Limited at 26 Blythswood Square. He succeeds **Mr. S. H. Foster** who has taken up other duties at Renold House, Manchester.

Mr. H. W. Wright, A.M.I.E.E., has been appointed head of the electrical dept. of Keith Blackman Limited, at the head office and works at Tottenham. This appointment is occasioned by the death of **Mr. J. Kenyon, M.Sc.,** Keith Blackman's chief electrical engineer for the last thirteen years. Mr. Wright has been with the company for twenty-nine years.

Obituary

WE regret to record the death of **Mr. Herbert John Stone, M.C., M.I.E.E.,** a director and general manager of British Insulated Callender's Cables Limited. Mr. Stone was also chairman of BIC (Export) Limited and deputy chairman of BIC Construction Company Limited, BIC (Submarine Cables) Limited and British Copper Refiners Limited.

Addresses

HAYCOCK GAUGE & TOOL COMPANY LIMITED, is the new title which has been adopted by the firm formerly known as A. H. T. Limited, of Brays Lane Coventry. The managing director, Mr. Harold J. Haycock, was formerly Joint managing director of John Harris Tools Limited, of Warwick.

F'AG BEARING COMPANY LIMITED have opened a new branch office at 86 Bristol Street, Birmingham 5 (Tel: MIDland 9209), under the management of Mr. E. B. Steer. A branch has also been opened at 69 Temple Street, Wolverhampton (Tel: W'ton 20386), under the management of Mr. V. Sedgeley.

A NEW product department devoted to semiconductors, has been created in the A.E.I. Radio and Electronic Components Division, with sales organization at 155 Charing Cross Road, London WC2, under the managership of Mr. F. Szekely.

C. J. R. ELECTRICAL AND ELECTRONIC Developments Limited, Bickford Road, Witton, Birmingham 6, have changed their name to Witton Electronics Limited.

CAWLEY PLASTICS LIMITED of Wey Lock works, Byfleet Road, New Haw, Weybridge, Surrey, has changed its title to Tough Plastics Limited.

BRITISH INSULATED CALLENDER'S CABLES Limited announce that their 'Panelec' Heating Division has been transferred from 21, Bloomsbury Street, WC1, to 83/85, Saffron Hill, London EC1. Telephone Holborn 3994.

S. N. BRIDGES & CO. LIMITED, York Road, London SW11, have opened a new sales and service centre in Birmingham at 128/129, High Street, Bordesley, Birmingham 12.

HOLBROOK MACHINE TOOL COMPANY LIMITED, 44-48 Martin Street, Stratford, London E15, announce that their registered offices and administration have been transferred to Cambridge Road, Harlow, Essex. Telephone Harlow 2257.

EXPANDITE ADHESIVES LIMITED, a subsidiary company within the Expandite Group, has been formed to manufacture and market a range of adhesives and will operate from office and factory premises at Birchley Street, St. Helens, Lancashire. Telephone St. Helens 7376/7. Telex 25420.

STEWARTS AND LLOYDS LIMITED have set up a pipework engineering division to be responsible for the making and marketing of all forms of manipulated pipework. Offices of P.E.D. are at Broad Street Chambers, Birmingham 1, and 41 Oswald Street, Glasgow C1.

SOUTHERN INSTRUMENTS LIMITED of Camberley, and The Drayton Regulator and Instrument Company Limited, have jointly formed a new company, Drayton-Southern Limited (West Drayton, Middlesex) for the purpose of expanding the instrumentation and control interests of both companies whose research production and sales resources will be available to it.

A NEW company, Foundry & Metallurgical Equipment Company Limited with headquarters at Netherby, 161 Queens Road, Weybridge, Surrey, has been formed by Efco Limited and Stein & Atkinson Limited.

Business Developments

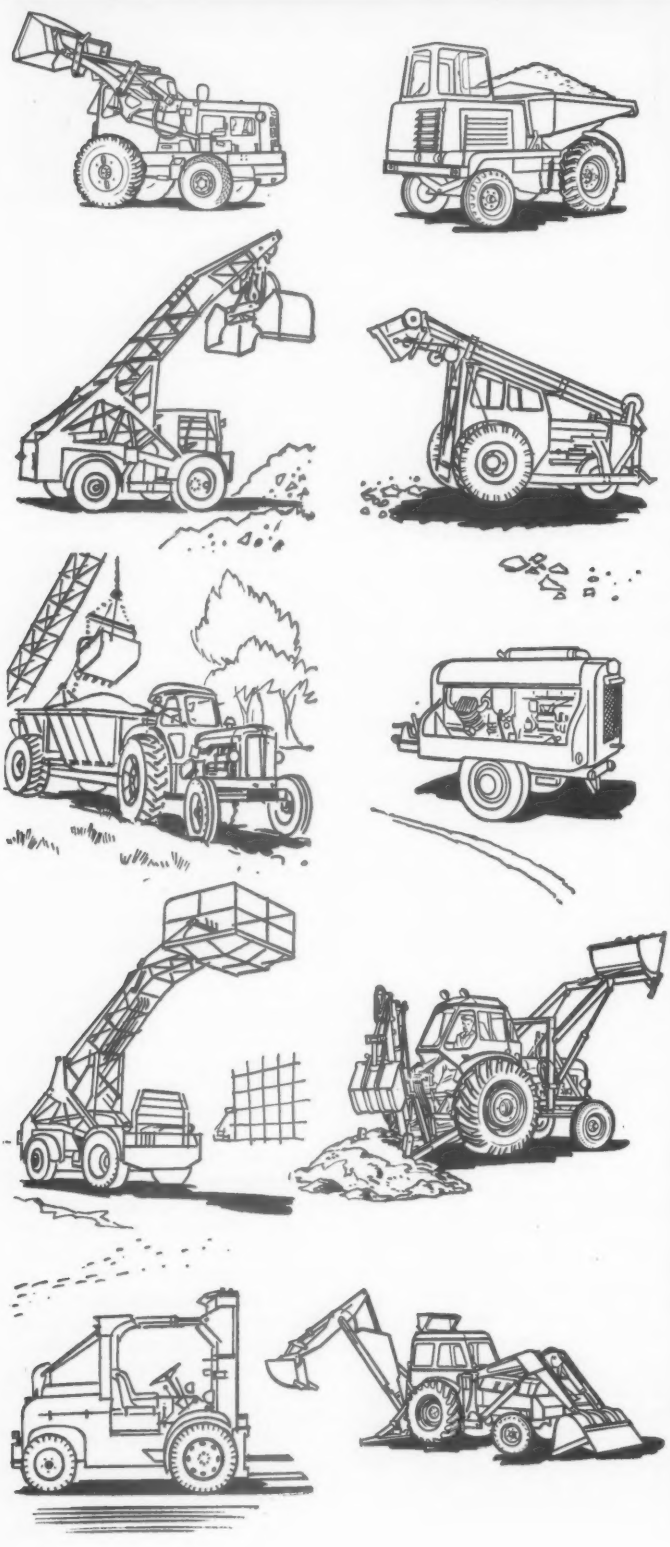
Trading agreements

AIMED at increasing the sale of British-designed electronic equipment in the United States, a recent joint announcement by E.M.I. Electronics Limited of London and Fairbanks Whitney Corporation of New York confirms the arrangement for the latter company to market most of the range of electronic equipment designed and manufactured by E.M.I.

FOUNDRY AND METALLURGICAL EQUIPMENT Limited, the new concern formed by Efco Limited and Stein & Atkinson Limited, will manufacture and supply, under licence, the Efco-Diamond rotary reactor for desulphurizing iron and steel by a new method developed in the U.S.A. by the Diamond Alkali Company. Arrangements have been completed with Sinex Engineering Company Limited for the new company to offer Sinex vibratory equipment and with Aldridge Industrial Oils of Cleveland, U.S.A., for the sale of die lubricants.

THE CAPE ASBESTOS COMPANY LIMITED of London has formed, in conjunction with Bruno y Cia Com E Ind SRL of Buenos Aires and with the Johns-Manville International Corporation of U.S.A., a new company under the name Bruno-Cape SA for the manufacture of asbestos fibre jointings and other asbestos goods in a factory in Buenos Aires. Other ventures are

EXPERIENCED OPERATORS INSIST ON



FORDSON POWER

Men who have kept to the tightest schedules in the toughest conditions; men who have manned machines working round the clock, seven days a week; these are the men who know from experience that for proved reliability Fordson Power is unequalled. Add to reliability all the other Fordson advantages of high output, low costs, unrivalled service and spare parts organisation, and almost unlimited choice of build-ups in the 30-40 and 40-50 b.h.p. classes. That's why more Fordson power units than any other are used in industrial equipment. Write for detailed specifications.

WISE BUYERS INSIST ON FORDSON POWER

INDUSTRIAL SALES DEPARTMENT · TRACTOR DIVISION
FORD MOTOR COMPANY LIMITED · DAGENHAM ESSEX

an agreement with Montisol Argentina SRL and the expansion of the asbestos textile factory of Filasbest SA of Buenos Aires.

THE German associates of M.E.P.P. Limited (Modern Electrolytic Patents and Processes Limited, Roto-Finish Works, Mark Road, Hemel Hempstead, Herts)—Elektrolyse, Gesellschaft m.b.H. of Munich, have concluded licence agreements with two well-known plating supply firms, Friedrich Blasberg, and Deinert & Co.

ALBERT MANN ENGINEERING COMPANY Limited of Basildon, Essex, have concluded a licencing agreement with Loma Machine Manufacturing Company Inc. and its subsidiary Lobeck Casting Processes Inc., of New York City, U.S.A., facilitating the supply of Loma and Lobeck metal processing equipment in the British Commonwealth, exclusive of Canada, and to the Outer Seven countries of the European Free Trade Association.

Company acquisitions

ALBERT MANN ENGINEERING COMPANY of Basildon, Essex, have taken over the whole of the share capital of Roll Race Conveyors Limited, late of London, W1 and will now manufacture and sell conveyors and handling equipment incorporating the patented Roll Race system of rolling loads.

Agents and distributors

ALFRED HERBERT LIMITED have been appointed agents for the sale of Crawford collets in the area covered by A. Herbert's Newcastle branch office where stocks will be maintained.

Contracts and Work in Progress

THE ENGLISH ELECTRIC COMPANY LIMITED.—Order from the Sudan resulting in a turnkey contract for a textile mill worth nearly £6m. for the British consortium comprising The English Electric Company Limited, Platt Brothers (Sales) Limited, and Marples Ridgeway and Partners.

HUMPHREYS & GLASGOW LIMITED.—(In association with Petrocarbon Developments Limited). Ethylene plant for the German Democratic Republic with a capacity of 40,000 tons p.a.

JAMES BOOTH ALUMINIUM LIMITED.—£1½m. order placed with Loewy Engineering Company Limited, Bournemouth, Hants., for mechanical side of new rolling mill to be installed by James Booth as the first part of its £5m. re-equipment and expansion programme at Kitts Green Works, Birmingham.

AVO LIMITED (MI GROUP).—Order from Ministry of Aviation for signal generators valued at £18,000.

TAYLOR ELECTRICAL INSTRUMENTS (MI Group).—Order from G.P.O. for 500 multi-range meters valued at more than £5000.

BROOKHIRST IGRANIC (MI GROUP).—Order from the Rouen newspaper *Paris-Normandie* for three newspaper conveyors. Also order for eight conveyors for the *Daily Mirror*.

WHARTON CRANE AND HOIST COMPANY Limited, Reddish, Stockport.—Over £300,000 orders for overhead electric travelling cranes for Richard Thomas and Baldwin's new steel rolling mill at Llanwern.

GENERAL ELECTRIC COMPANY LIMITED.—£2½m. contract for rolling mill equipment for Richard Thomas & Baldwins Limited Spencer Works at Llanwern, Mon.

Further contract valued at £2m. for power plant and electrical equipment for Colvilles Ravenscraig Iron and Steel Works, near Motherwell.

SOUTH AFRICAN contracts for coal preparation plants worth £230,000 secured by The British General Electric Company (Pty.) Limited, Johannesburg, which represents G.E.C. England in South Africa.

WESTINGHOUSE BRAKE AND SIGNAL Company Limited.—Further Rectifier contracts for two high-speed tinning lines—one for Richard Thomas & Baldwins Limited at Ebbw Vale, and the second for Australian Iron and Steel Limited, Port Kembla Works.

A.E.I. LIMITED. TURBINE GENERATOR Division.—Order from Atomic Energy of Canada Limited for a 220MW steam turbine generator, valued about £2m.

HEAVY PLANT DIVISION.—Order valued at more than £200,000 from the tinplate division of the Steel Company of Wales for germanium rectifiers for a third tinning line at Trostre Works, Llanelly. Order worth more than £400,000 for equipment at Bell Bay, Tasmania. Order for plant for hot strip roughing mill for Richard Thomas and Baldwins Spencer Works at Llanwern, value about £1,800,000.

BRITISH RAILWAYS.—Order placed with Herbert Morris Limited of Loughborough for two overhead cranes for British Railways Doncaster Locomotive Works.

GRIFFIN & GEORGE LIMITED, Alperton, Wembley, Middlesex.—Contract valued at £10,000 for scientific equipment for the laboratories of the new Mid-Hertfordshire College of Further Education at Welwyn Garden City, Herts.

Film News

Industrial Pipework.—This 10 minute film has been produced as part of an advertising campaign launched by Stewarts and Lloyds Limited new Pipework Engineering Division. Copies of the film are available to customers of the company, trade organizations and other interested bodies.

Trade Literature

Polygon Tool Box

The versatile Polygon tool box, with which components can be produced in hexagon, octagon, square and other shapes from round stock entirely by turning operations is described in a handsome new 40-page illustrated brochure issued by Thomas Chatwin & Co. Limited, Great Tindal Street, Birmingham, a member of the Brockhouse Group. The brochure, which is in sectional form, outlines the various functions of the box and includes detailed operating instructions and diagrams. Also included are tabulated charts showing capacities of the box when fitted to capstan and turret lathes, single and multi-spindle automatics and special machines. Copies of the brochure can be obtained direct from the company at the above address.

Designing for Diecasting

A useful technical booklet for designers who order some of their components to be made as diecastings is available free to *Mechanical World* readers from Fry's Diecasting Limited, Merton Works, Prince George's Road, Merton Abbey, London SW19. It explains, with clear illustrations, just how to embody those little details which make for economy and a thoroughly satisfactory product.

Rigidex Polyethylene

Rigidex high density polyethylene is well demonstrated in a new publication issued by British Resin Products Limited, Devonshire House, Piccadilly, London W1. The rigidity and corrosion resistance of Rigidex have led to its use for suction strainers in pumping systems for quarries, mines and storage tanks. Valves and taps for petrol, paraffin and solvent containers are also moulded in Rigidex. Paint does not adhere to the Rigidex handles of paint brushes. The stiffness of Rigidex sheet makes it useful in the fabrication of chemical plant. It has excellent electrical characteristics.

Fan arrangements

Keith Blackman Limited, Mill Mead Road, London N17, have prepared a new folder which shows very clearly the various standard directions of discharge of their Tornado centrifugal fans, blowers and exhausters. It will be invaluable to actual and potential users and is readily available to interested parties from the company's Publicity Department at the address given above.

Rapier Engineering Products

Two new folders from Ransomes & Rapier Limited, Ipswich, illustrate the variety of machinery made by the firm. One shows in brief outline the various works

departments and the other some typical mechanical handling and contractors' equipment.

Flexible Metallic Hose

An 18-page illustrated brochure describing Plessiflex flexible seamless metallic hose is now available from Power Auxiliaries Limited, Kembrey Street, Swindon. Many applications are illustrated and tables give full specifications.

Teleprinters

Creed & Co. Limited, Telegraph House, Croydon, have issued some new publications on their teleprinters. The Model 54 machine is for general purposes and provides for the telegraphic communication of messages and other data in printed page form, Models 85 and 86 printing reperforators automatically record incoming telegraph messages and other data on paper tape, both as fine-track code perforations and corresponding characters. A new folder describes the Creed teleprinter installation in the Wiggins Teape organization.

Induction Heaters

Four new folders from Delapena & Son Limited, Tewkesbury Road, Cheltenham, Gloucestershire, describe ten models of the Delapena induction heater. They range from 4 kW to 50 kW output and, as shown by examples of the kind of work performed by each, cover a wide field of application. Each machine is described fully and particulars are given of the duty and dimensions in each case and of the supplies required.

Bailey Air Relay

Bailey Meters & Controls Limited, Purley Way, Croydon, have issued Product Specification No. (E) P99-8 which describes and illustrates their pneumatic relay for use in automatic control systems. The relay receives pneumatic signals from transmitters, controllers and/or other relays and produces a control signal according to the computing or control action desired. Twelve circuit-type diagrams show the relay to be a versatile instrument.

"Starting from Scratch"

The booklet of this title issued by Higgs Motors Limited, and dealing with the company's history and activities, has been brought up to date in a new edition which is now available on request to their head office at Witton, Birmingham 6. An aerial view taken in 1959 gives a good idea of the extensive works.

Colloidal Graphite and Graphite Dispersions

The use of Foliac colloidal graphite in power stations is the subject of a new leaflet issued by Graphite Products Limited, Northfields, Wandsworth Park, London SW18. Brusn spring spindles, rolling contacts, valve stems, circuit breakers, chain blocks and soot blowers are among the many details for which this form of lubrication is eminently suitable. Foliac colloidal graphite is supplied in both water and alcohol dispersions.

The same two dispersions and also Foliac colloidal graphite in mineral oil and castor oil are dealt with as regards their other, widely different uses in a new folder which gives examples of lubrication under arduous conditions and applications to ensure parting of joints, for coating cathode tubes, etc.

Trade Literature

Readers interested in any of the catalogues reviewed here can obtain copies by mentioning* MECHANICAL WORLD *when writing to the firms concerned.

Files and Rasps

"Cyclops" files and rasps have been top quality tools for over 120 years. Nowadays, control of this quality begins in the electric melting furnaces and continues through every stage of manufacture. Just how comprehensive the range in style, size and cut is revealed in a new E.S.C. publication entitled "Files and Rasps", which as well as technical notes on test data and the use of the tools, gives very clear illustrations of shapes and sections, and tabulations of weight and length for each section. Any reader of MECHANICAL WORLD can have a free copy of the booklet by writing to Mr. G. H. Fisher, Publicity Manager, English Steel Corporation Limited, River Don Works, Sheffield 9.

Bahco Automotive Tools

A catalogue from Condrup Limited, 67–73 Worship Street, London EC2, illustrates the range of Bahco automotive spanners, wrenches and screwdrivers made by the A. B. Bahco factory in Sweden, for which Condrup Limited are the sole U.K. agents. Additions to the range now made for the British market are all the important nut driving sockets and open ended and ring spanners, including open ended and offset ring on the one tool.

Innocenti Works and Products

A "news letter" in the form of a handsome brochure in full colour comes from Innocenti, 58–59 Trafalgar Square, London WC2, describing the company's works and mechanical engineering facilities at Milan, Italy. The mechanical engineering shops are extensive and well-equipped and typical products illustrated include a large milling machine, a tube rolling mill, a blooming mill, a micro-inching mechanism, and a tube expanding plant. The use of an Innocenti milling and boring machine for machining the cylinder body of a compressor is described in detail.

Packaging Machinery

Leaflets from H. & B. Precision Engineers Limited, Colonial Way, Station Estate, Watford, give particulars of some new packaging machinery. The Mark III loose filling machine is for bench or pedestal mounting and handles various materials whether granular or free flowing. A light-sensitive switch is for controlling lights automatically at dusk and dawn, and a pleat wrapping machine is offered for the overwrapping of small packs.

Engineering Service to Industry

The extensive facilities for engineering manufacture and construction at the works of Ashmore, Benson, Pease & Co. Limited, Stockton-on-Tees, are well described and illustrated in a handsome brochure newly issued by the company. The works has been largely rebuilt during the last ten years, and on a plan which allows of continuing expansion for some time ahead. The company is well known for its long experience in the design, manufacture and erection of all kinds of heavy plant, and to-day it produces plant, mechanical equipment and structures to the most stringent requirements.

Explosive Gas Detection

A new electronic detector of explosive gases is described in a leaflet issued by I.E.C.–Sieger Limited, 39 Parliament Street, London SW1. It uses a catalyst which is heated by an electric current in a balanced circuit. In the presence of inflammable gas the electrical resistance of the catalyst alters and this unbalances the electrical bridge and causes the instrument to give audible warning.

Stiffer and Tougher Mouldings by Blending Rigidex

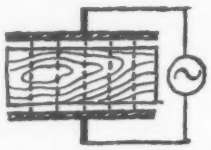
Blending Rigidex high density polyethylene with conventional polyethylene gives mouldings with properties superior to conventional polyethylene on its own. The following qualities are improved in direct proportion to the amount of Rigidex incorporated: 1, Stiffness; 2, Tensile Strength; 3, Softening point; 4, Resistance to solvents. Details are contained in Technical Information Sheet No. 5 issued by British Resin Products Limited, Devonshire House, Piccadilly, London W1, from whom copies are available on request.

Holmes-Schneible Multi-wash System

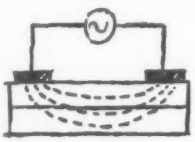
When the collection of dust or fume in the form of sludge or liquid effluent is acceptable or desirable, the Holmes-Schneible multi-wash system offers the advantages of efficient ducting, high efficiency dust collection, low power

Dielectric Heating - 1

When an electrically non-conducting material is placed between two metal plates, called electrodes, connected to an A.C. supply, the alternating electrostatic field between the electrodes considerably speeds up the molecular movements in the material (termed a 'dielectric') as a result of which the temperature of the material under treatment rises. A similar effect is produced where the two electrodes are positioned on the same side of the dielectric; in this case the electrostatic field between them is generally known as a 'stray' or 'fringe' field.



For industrial application, the applied voltage of the order of 15,000 volts supplied by an electronic generator alternates at frequencies of some millions of cycles per second.



The amount of heat generated in the dielectric is determined by the frequency, the square of the applied voltage, the dimensions of the object and a physical property of the material termed "loss factor" and is represented by the equation:—

$$\text{Power} = 1.41\ E^2\ f.\ F\ \frac{A}{t} \times 10^{-15} \text{ kilowatts.}$$

Where E = applied voltage, f = frequency, F = loss factor.

A = area of the dielectric in square inches.

t = thickness of the dielectric in inches.

F, the loss factor, is itself equal to the expression K Cos Ø in which:
K = the dielectric constant, a measure of the property of the material to retain energy arising from disturbance of its molecular structure.

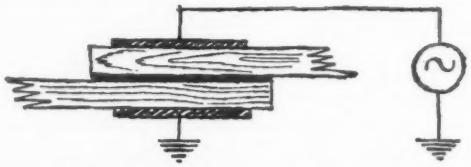
Cos Ø = the dielectric power factor of the load, that is the ratio of the power (in watts) to the product (in volt-amperes) of the voltage and current. This is a characteristic property of the material.

Therefore, "loss factor" is a property of the material and a measure of the ease with which it can be heated by this method. Like other physical properties, it varies considerably for different substances. The equation shows that the heat generated in a dielectric is proportional to its loss factor, but the rate of rise of temperature will also depend upon its specific heat and density. The following table gives approximate values of the dielectric constant, power factor and loss factor of a few typical dielectric materials for frequencies around a million cycles a second.

MATERIAL	DIELECTRIC CONSTANT	POWER FACTOR	LOSS FACTOR
Natural Rubber	2.9	0.02	0.058
Oak, dry	3.3	0.04	0.132
P.V.C.	5.3	0.06	0.318
Urea formaldehyde	7.0	0.03	0.21
'Bakelite' resin	6.0	0.03	0.18
Nylon	3.7	0.05	0.185
Water, pure	80.0	0.03	2.40
Water, tap	80.0	0.5/5.0	40/400

The high loss factor of water means that materials which are difficult to heat when completely dry will often heat efficiently when moisture is present. The voltage must be increased towards the end of the process in some cases to remove the final moisture traces, the reduction in loss factor as the material dries out providing a safeguard against overheating.

Dielectric heating of a homogeneous material is a straightforward application, heat being generated uniformly throughout. If the workpiece is made up of a number of materials, each material will heat up uniformly but each at a rate depending upon its loss factor, thermal properties and density. The degree of temperature uniformity throughout the workpiece will then depend upon the extent to which thermal conductivity can equalise different rates of heating.



Such different rates of heating can be turned to good account in certain applications. For example, in wood glue setting, the glue lines heat up much more rapidly than the wood pieces being joined and the glue sets before the wood heats up substantially, wood having a lower loss factor than glue. Dielectric heating does not depend upon any external heat source to transfer heat by conduction, convection or radiation to the surface of the charge and from thence to the interior by conduction.

Instead, heat is generated within every particle of a body placed in the dielectric field and, depending upon the uniformity of such a body, an even and extremely fast temperature rise can be achieved.

For further information get in touch with your Electricity Board or write direct to the Electrical Development Association, 2 Savoy Hill, London, W.C.2. Telephone: TEMple Bar 9434.

Excellent reference books on electricity and productivity (8/6 each, or 9/- post free) are available—"Induction and Dielectric Heating" is an example.

E.D.A. also have available on free loan in the United Kingdom a series of films on the industrial uses of electricity. Ask for a catalogue.

4774

consumption, separate dewatering and convenience in the disposal of the sludge. The plant is fully described and illustrated in a new technical brochure (Publication No. 80) available from W. C. Holmes & Co. Limited, P.O. Box No. B7, Turnbridge, Huddersfield.

Indicating Instruments

There are no less than 150 standard ranges and scales available for the Honeywell indicating millivoltmeter, thus enabling it to be used for indicating temperature, speed, or other quantity which is measured by electrical means. There is also a variety of cases and types of plug-in control units from which to choose. Full details are set out in a new broadsheet available from Honeywell Controls Limited, Ruislip Road East, Greenford, Middlesex.

Diameter Broaches

W. H. Marley & Co. Limited, 105 High Road, London N11, make diameter broaches in sizes increasing by $\frac{1}{16}$ in. from $\frac{1}{16}$ in. to 1·0 in. nominal diameter. The broaches are made to precision tolerances from 18% tungsten high-speed steel. Full details and dimensions are set out in a new leaflet available from the company.

Dorman Long in 1959

A booklet from Dorman, Long & Co. Limited, Zetland Road, Middlesbrough, illustrates the activities of the company during last year. They include rolling mills, chemical manufacture, sales organization, structural steelwork and bridge building, sintering plant, and wire works development.

Mirrlees Chokeless Pump

To overcome certain disadvantages encountered in sugar manufacture, The Mirrlees Watson Company Limited, 45 Scotland Street, Glasgow C5, have developed a system using the Mirrlees Chokeless pump. The system is fully described and illustrated in their catalogue No. S337. The company has already had much experience in the application of this type of pump to the pumping of solid-liquid mixtures such as sewage sludge and bilge water, and already there is a considerable number of these pumps handling unstrained cane juice in sugar factories throughout the world.

Continuous Bright Annealing

A new folder from Metalectric Furnaces Limited, Cornwall Road, Smethwick 40, Staffordshire, describes their bright annealing furnaces. Types using woven wire mesh belt, roller and pusher hearths are made to suit different products and the company also supply atmosphere plants for excluding oxygen from the furnace.

Fischer Bearings

A booklet from F'AG Bearing Company Limited, Macrome Road, Green Lane, Tettenhall, Wolverhampton, attributes the foundation of the ball-bearing industry in Europe to the first bicycle with pedals invented by Philipp Moritz Fischer of Schweinfurt in 1852. In 1883 his son Friedrich Fischer founded a small workshop in Schweinfurt where he developed the machine for manufacturing bearing balls in quantity. Today, the F'AG organization is one of the largest suppliers of a great variety of ball and roller bearings and associated components.

PowerGrip Timing Belts

The advantages of the PowerGrip timing belt are its shear-resistant neoprene teeth which engage with toothed pulleys, its continuous helically wound steel cable tension members to carry the load, its strong, flexible and durable neoprene

backing bonded to the steel cable, and its nylon-faced wear-resistant contact surface. The belt is made with ½ in. pitch teeth in five widths from ¾ in. to 3 in., and stock drives are available from fractional to 64 hp at 6000 rpm. Larger sizes up to 1000 hp are available at short notice. The maker's catalogue (ask for Publication 359) contains complete technical data: it is available from Crofts (Engineers) Limited, Bradford 3, Yorkshire.

"Cov Rad"

Although the Coventry Radiator and Presswork Company Limited has always had close associations with the automotive industry, it makes a wide range of other products, notably industrial oil and gas-fired space heaters, condensers for refrigeration and air conditioning units, oil coolers and heat exchangers for internal combustion engines and for processing liquids in the chemical and oil industries. Like most companies it began modestly. It was founded during the latter part of the nineteenth century and quickly established a reputation for high quality products. The present factory at Canley was built in 1930 and it has since developed and expanded into the modern plant which forms the subject of a handsome brochure, with pictures in full colour, which has recently been published by the company.

Aluminized Asbestos Cloth

A really versatile finishing wrap for lagging installations has been developed by Turner Brothers Asbestos Company Limited, P.O. Box No. 40, Rochdale, Lancashire. Being made of aluminized asbestos it has all the advantages of a fireproof cover cloth while providing excellent appearance. It is strong, durable, impermeable to moisture and heat reflectant. Technical details are set out in a new leaflet now available from the company at the address given above.

Rubber Conduit Strip

A double-wedge shaped rubber conduit strip which enables electric wiring to be safely laid on the floor or in other exposed places is described in a leaflet from Vulcascot (Great Britain) Limited, 87/89 Abbey Road, London NW8. It cannot be tripped over and trolleys can pass over it without causing damage.

New Factories

Middlesbrough. Globe and Simpson, Limited, electricians. The architects for proposed alterations and additions in Linthorpe Road are Doffman and Leach, 17 Wolverhampton Road, Stafford.

Newcastle upon Tyne. The Regional Hospital Board have accepted the tender of Bennis Combustion Limited, Manchester, at £3,449 for the supply of a coal-handling plant for Darlington Memorial Hospital.

Ponteland (Northumberland). Cordar, Limited, Dean Street, Newcastle upon Tyne, are to erect a new factory at Ponteland. Plans are in hand and tenders will be invited in due course. The architect is C. S. Errington, 46 Grainger Street, Newcastle upon Tyne.

Sunderland. Cottam and Company, Lambton Street. Brush factory and offices to be build in Henry Street East. The contractors are Sloan and Earnshaw, 60 Dundas Street.

Belper. Ambergate Wire Works Limited are considering making extensions to their works.

Birkenhead. Merseyside Engineering (Refrigeration) Limited propose to build a new factory.

Bolton. R. Threlfall Limited are to make extensions to their works in Shifnal Street.

Burnley. Eric Cowpe Limited are planning extensions to Oakbank Mill.

Burton-on-Trent. Print Paper Limited, Moor Street, are to build a new factory at Wellington Street.

Bury. Olives Paper Mill Company Limited, Woolfold Works, are to extend their factory.

Cardiff. Trixfa Limited are seeking permission to erect a new factory at East Canal Wharf.

Crewe. Morning Foods Limited. Extensions to factory.

Cromer. Argent Box Company Limited, 225 Southwark Bridge Road, London SE1. A new factory is proposed near Shippen Avenue.

Croydon. Bailey Meter & Controls Limited. The architect for new factory premises is R. W. Lone, 15 New Square, Lincoln Inn, London WC2.

Doncaster. Harrison Gibson Limited, Wheatley Hall Road. Extensions to works.

Enfield. Edwards & Company, Aden Road. Extensions to factory.

Fleetwood. Imperial Chemical Industries Limited are to extend their factory at Thornton.

Glasgow. Govancroft Potteries Limited, London Road, Glasgow E2, are to make extensions to their factory.

Hatfield. Stafford-Miller Limited, 166 Great North Road. The architect for extensions to the works is C. W. Fox, 22 Parkway, Welwyn Garden City.

Hereford. H. Wiggin & Co. Limited, Holmer Road. Works extensions.

High Wycombe. E. & L. Products (High Wycombe) Limited, Victoria Street. A new factory is to be built on the Lincoln Road site.

Hinckley. C. Wilbur Limited, 43-45 New Street. Plans have been approved for works extensions.

L. Grewcock & Co. Limited. Extensions are to be made to the factory at Baptist Walk.

Kidderminster. H. I. J. Engineering Company Limited are to make extensions to their factory in Worcester Road.

Lichfield. Edgar Vaughan & Co. Limited, Eaton Road, Coventry. A new factory is to be erected at New Road industrial site.

London. Middlesex Tool & Gauge Company Limited, Park Royal Road, London NW10. Factory extensions.

Macclesfield. W. Hargreaves & Co. Limited, Stockport. A new factory is to be built on the Hurdsfield industrial estate.

Maidenhead. British Filters Limited, Old Street, Cox Green. The architects for new factory and offices are North & Partners, 40 The Broadway.

Maidstone. Kent Engineering & Foundry Limited, Church Road, Tovil, are to make extensions to their works.

Northampton. Leather & Ferrersflex Components Limited, Rushden, are to make extensions to their factory at King's Heath, Dallington Field industrial estate.

Penkridge. Frisky Cars (1959) Limited are to erect a new factory comprising initially 12 bays.

Peterborough. Peterborough Die Casting Company Limited. Extensions are to be made to the factory at Padholme Road.

The Precision Tools & Equipment Engineers, Star Road, are to make extensions to their factory.

Poole. Flight Refuelling Limited, Tarrant Rushton, near Blandford, are to erect a new factory in the Bourne Valley.

Portsmouth. Aluminium (Portsmouth) Limited, 41 Belmont Street, Southsea, are to build a new factory in Fitzherbert Road.

S.E.B. Upholstery Limited, Cosham, are to extend their factory in Western Road.

Redditch. Edgar Sealey & Sons Limited are to make extensions to their factory in Hewell Road.

Marla Metals Limited have applied for a new site for a new factory.

Southport. Arnold Kinnings & Sons Limited, 168a Norwood Road. A new factory is to be erected in Meols Cop Road.

Staines. W. E. Sykes Limited. Extensions to Manor Works.

Torquay. The Sifam Electrical Instrument Company Limited, Higher Linscombe Road are to erect a new factory on the Old Wools Trading Estate.

Totnes. South Western Flooring Company. A new factory and offices are to be erected on the old race-course site.

Aberdeen. Spillers Limited, London, have begun construction of a farm feedstuffs manufacturing and processing plant at Albert Quay.

Glasgow. Alliance Box Company (Scotland) Limi ed are to rebuild larger storage and handing space at their Hamilton Hill Works, Springburn, to replace those recently destroyed by fire.

King Aircraft Corporation, Hillington, have sold an interest to the overseas subsidiary of the H. K. Porter Company, Inc. of Pittsburgh. This will mean expansion of the Hillington Works and introduction of new products from the H. K. Porter range of equipment.

Robert MacLaren & Co. Limited are to extend their existing factory premises on ground between Mauchline Street and West Street, Glasgow.

D. C. Thomson & Co. Limited, printers and publishers, have received approval for a four-storey extension and basement to their printing works at 120-144 Port Dundas Road.

Wallace Cameron & Company have received planning permission for a factory and office block at Drakemire Drive, S4.

Lawson & Sons (Dyce) Limited, bacon processors, have received permission to extend their factory premises at 100 Logan Street, C5.

Wallasey. Hutchison & Co. (Glasgow) Limited, sheet metal workers, have acquired Harben & Company, fabrication engineers, of Wallasey, Cheshire. They will reorganize and re-equip the Harben Works with modern machinery and organize to handle large-scale fabrication projects from this plant.

CLASSIFIED ADVERTISEMENTS

Situations Vacant

BUYER required to train as Buying Manager for Steel Stockists. Appropriate experience essential. Apply in writing to: Mr. Duffield, The Mulberry Company, Castle Wharf, Orchard Place, London E14.

Machinery, Plant and Accessories For Sale

SNOW Horizontal Surface Grinder Type CS/46/20 MC, new 1950. Capacity 24 in. diameter, 20 in. straight, 24 in. periphery. Motorized 400/440, 3-phase, 50 cycles. Igranic Controls. Ready for immediate use. Apply: Thomas Jenkins & Son Limited, 4/6 Exchange Buildings, Port Talbot, Glam.

"FRIGIDAIRE" Low Temperature Refrigerators. 49 in.w × 28 in.d × 34 in.h ext. Ex Large National User, suitable A.C. or D.C. Deep Freezing, Storage of Ice Cream, Frozen Foods, etc. Price £40.0.0 each. Domestic Refrigerators, Service Cabinets and Cold Rooms also available. A.R.C., 134 Great Portland Street, London W1. MUSeum 4480.

FANS! ! ! for Dust, fume extraction, air conditioning, compressors, accessories, motors, etc.; at considerably reduced prices. People say—"If only we'd known of you before . . . Write for very interesting list. Bellangers, 306 Holloway Road, London N7. North 4117.

PUMPS for all purposes. R. L. Christiansen Limited, Wordesley, Stourbridge. Brierley Hill 78184/5.

Machinery, Plant and Accessories Wanted

WANTED. HORIZONTAL OIL ENGINES, LAMP START AND COLD START DIESEL, ETC. 12 H.P. TO 100 H.P. M. BLOOMFIELD & SONS, DEBENHAM 353/4.

Patents For Sale or License

THE proprietor of British Patent No. 718976, entitled "IMPROVEMENTS IN OR RELATING TO COUPLINGS FOR RODS, TUBES AND THE LIKE", offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 14 E. Jackson Blvd., Chicago 4, Illinois, U.S.A.

THE proprietor of British Patent No. 760973, entitled "MACHINE FOR APPLYING MATERIAL TO WALLS AND OTHER OBJECTS" offers same for license or otherwise to ensure practical working in Great Britain. Enquiries to Singer, Stern & Carlberg, 14 E. Jackson Blvd., Chicago 4, Illinois, U.S.A.

THE proprietors of British Patent No. 763619 for "Improvements in and relating to internal combustion engines and exhaust gas silencers therefor" are desirous of entering into negotiations with firms in this country for the purpose of exploiting the above invention either by sale of the patent rights or by granting of licences to manufacture on a royalty basis. Enquiries should be addressed to Abel & Imray, Quality House, Quality Court, Chancery Lane, London WC2.

Classified advertisements are inserted at the rate of 3/- per line.

THE proprietors of Patent No. 762429 for "Improvements in or relating to a Combined Free Piston Internal-combustion Engine and Air Compressor Assembly" desire to secure commercial exploitation by Licence or otherwise in the United Kingdom. Replies to Haseltine Lake & Company, 28 Southampton Buildings, Chancery Lane, London, WC2.

THE proprietors of Patent No. 760780 for "Improvements in or relating to a Combined Internal-Combustion Engine and Air-Compressor Assembly" desire to secure commercial exploitation by Licence or otherwise in the United Kingdom. Replies to Haseltine Lake & Company, 28 Southampton Buildings, Chancery Lane, London WC2.

THE proprietor of British Patent No. 682213, entitled "Forming Roll Machine" offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 14E. Jackson Blvd., Chicago 4, Illinois, U.S.A.

THE proprietor of British Patent No. 759094, entitled "A Gate Valve Assembly", offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 14E. Jackson Blvd., Chicago 4, Illinois, U.S.A.

Please mention

Mechanical World and Engineering Record

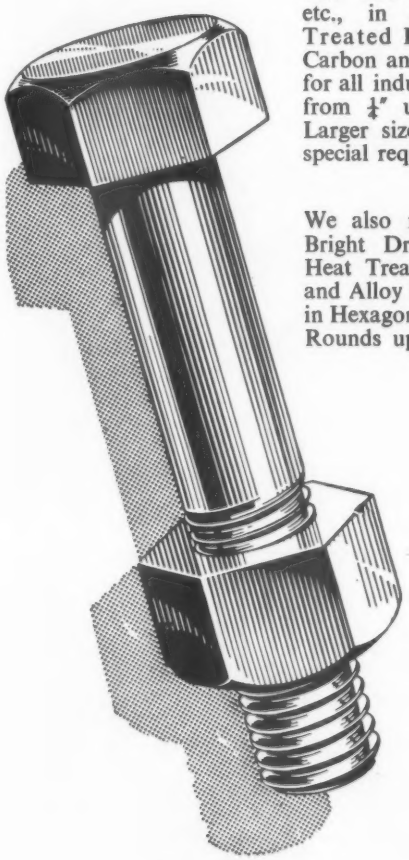
when replying to Advertisements

Marwin

BRIGHT & HIGH TENSILE bolts

Highest quality Hexagon Head Bolts, Nuts, Studs, Sets and special parts etc., in Bright, Heat Treated High Tensile Carbon and Alloy Steels for all industries, in sizes from ¼" up to 3" dia. Larger sizes supplied to special requirements.

We also manufacture Bright Drawn Heat Treated Carbon and Alloy Steel Bars in Hexagons, Squares and Rounds up to 3½" dia.



HIGH TEMPERATURE CREEP RESISTING STUD BOLTS

Specialised products that give great resistance when exposed to high temperature.

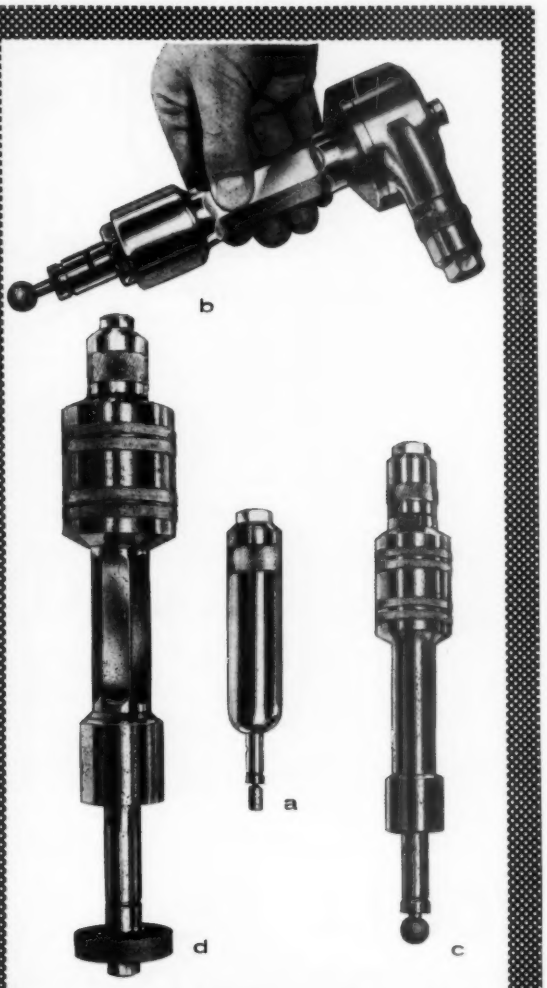
Sizes range from ⅜" to 3" dia.

Full technical details and Catalogue on request.

W. MARTIN WINN LTD.

DARLASTON · SOUTH STAFFS.

Phone: JAMES BRIDGE 2072 (5 lines). Grams "ACCURACY" DARLASTON



BRIGGS

"AJAX" AIR GRINDERS

proved the BEST for mounted points and carbide burs.

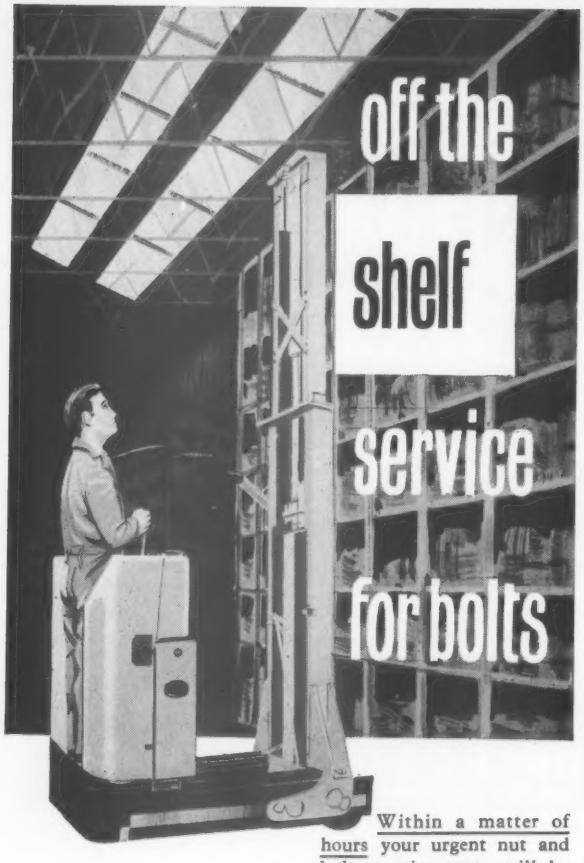
a AJAX JUNIOR 90,000/100,000 r.p.m.
b AJAX MARK III 50,000 r.p.m.
c BRIGGS MARK II 25,000 r.p.m.
d BRIGGS MARK IV 22,000 r.p.m. and BRIGGS MARK V 13,000 r.p.m.

MANUFACTURED BY

BRIGGS BROS (ENGINEERS) LTD

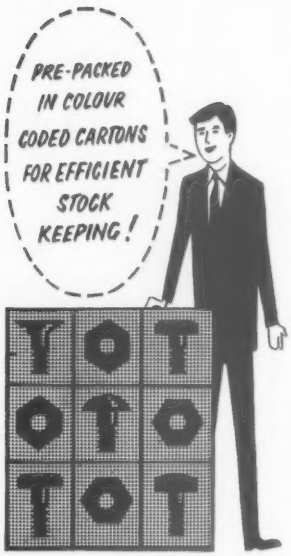
206, EDWARD ROAD, BIRMINGHAM 12, ENGLAND

Literature on request. Telephone: CALthorpe 2995



Within a matter of hours your urgent nut and bolt requirements will be supplied via the re-organised and super-efficient stock and despatch department at LANARKSHIRE BOLT.

A most comprehensive range of sizes in black, bright, high tensile, and many other metals can be sent by return. And if it's convenient you can collect your order self-service style. Specials? Certainly! And again with little delay.



Do you get our MONTHLY STOCK LIST?

Save time wasted in chasing supplies by asking for our FREE stock list, mailed every month to interested buyers. Please send name on firms letterhead to

LANARKSHIRE BOLT LIMITED

Hamilton, Lanarkshire, Scotland. Tel. 1241-4.

The last word in Drawing Office Efficiency

ISIS

DRAFTING MACHINES & DRAWING TABLES

Isis Drafting Machines are now fitted with improved Protractor Heads. The special features are fully explained in our ISIS folder which will be gladly sent on request. The ISIS Drawing Tables are in complete balance at any height or inclination of the board.

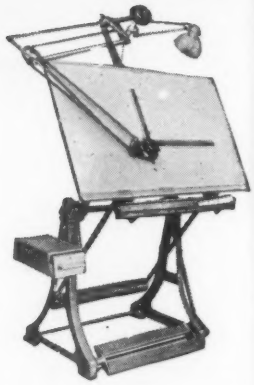


Illustration shows ISIS drawing table fitted with ISIS drafting machine

We are distributors of ARISTO *slide rules of precision*

RIEFLER DRAWING INSTRUMENTS OF QUALITY

J.W.SMITH (COVENTRY) LTD

DRAWING OFFICE SUPPLIES & EQUIPMENT

36 & 41 QUEENS ROAD, COVENTRY

Grams: "ISIS" COVENTRY
Tel: COV. 62058-9

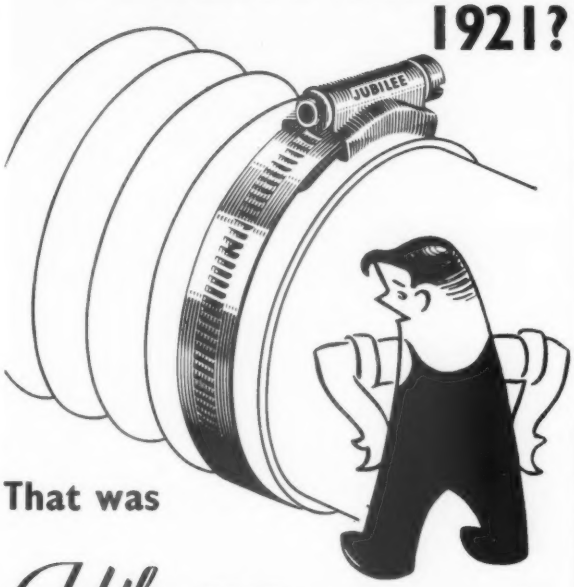
how much for this?

. . . not more than a shilling, maybe, but a single damaged bolt or other screw threaded part can cost pounds if a replacement is not readily available and essential machinery is standing idle. Why take chances when the certain safeguard costs only 27/6d? Put a Bolt Saver in your tool kit NOW before the next breakdown.

Re-forms damaged threads like new with full grip restored. Takes all sizes from ¼" to ¾" dia., and available for all standard threads.

Patentees and Sole Manufacturers:
LAWRENCE EDWARDS & CO. (ENG.) LTD.,
COMMERCIAL BUILDINGS · KIDDERMINSTER

HOWEVER DID THEY MANAGE BEFORE 1921?



That was

Jubilee REGD TRADE MARK YEAR— the year the

FINEST WORM DRIVE HOSE CLIPS IN THE WORLD

were born

GENUINE *Jubilee* REGD. TRADE MARK

WORM DRIVE HOSE **CLIPS**

Jubilee REGD TRADE MARK 'CLIPDRIVER' REGD TRADE MARK

COMPANION ACCESSORY TO THE WORLD'S FINEST CLIP

L. ROBINSON & CO. (GILLINGHAM) LTD.,
LONDON CHAMBERS, GILLINGHAM, KENT TELEPHONE: 51182/3

DON'T LET SOLDERING TIE YOU UP IN KNOTS...

use FLUXITE

Soldering ceases to be a knotty problem the moment you use FLUXITE. Solder flows on easily and smoothly—and stays on. For over half a century FLUXITE has been the choice of craftsman and engineer alike and, in this age, its reliability and speed has made FLUXITE even more in demand than ever.

IT SIMPLIFIES ALL SOLDERING

FLUXITE LTD.
Bermondsey St., London S.E.1
Hop 2632

GM 78

BALL, ROLLER, TAPER
ROLLER & NEEDLE BEARINGS
IN METRIC SIZES

DÜRKOPP

SOLE CONCESSIONAIRES AND STOCKISTS FOR UNITED KINGDOM

FLEXICON LTD

Head Office: 72 Vicar Lane, BRADFORD Tel: 23941, Telex: 51243
Also at: Foleshill Road, Coventry Tel: 27108
And: 61 St. Benedict's Street, Norwich Tel: 21795

SPRINGS, PRESSINGS,
WIREWORK AND SPRING WASHERS

ALL TYPES OF SPRINGS FOR ELECTRICAL AND MECHANICAL NEEDS

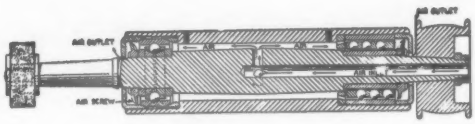
CHURCHFIELDS SPRING CO·LTD

BANK STREET, HALL END, WEST BROMWICH
TEL: STOnecross 2605/8 pBX

LONDON OFFICE: 4 PETERBOROUGH ROAD
HARROW, MIDDLESEX Phone: Byron 2859

AIR COOLED

INTERNAL GRINDING SPINDLES



- COOL AT 60,000 R.P.M.
- EXCEPTIONALLY RIGID
- GUARANTEED DUSTPROOF

These spindles will cut out your troubles and increase your Grinding Output

Write for details and prices from

The "SPIRO" Ball Bearing Co. Ltd.
"SPIRO" WORKS, KETTERING

Telephone: Kettering 2122 Telegrams: "SPIRO" Kettering

RADIO-FREQUENCY *too!!*

For many years it has been known that we Flame Harden the surface of components to give long life.

The same thermal treatment can be applied by Radio-frequency Induction methods with comparable results.

We therefore can combine a long experience in the surface hardening field with the use of our MODERN FULLY AUTOMATIC RADIO-FREQUENCY PLANT—valve sets up to 125 kVa.

YOUR ENQUIRIES ARE INVITED

FLAME HARDENERS LTD.
Shorter Works, Bailey Lane, Sheffield, 1
Telephone: 21627

Index to Advertisers

Published by the Proprietors, Emmott & Co. Limited, 31 King Street West, Manchester 3, and 158 Temple Chambers, Temple Avenue, London, E.C.4, and printed in Great Britain by The William Morris Press Limited, Wythenshawe, Manchester. Entered as second-class at the New York, U.S.A. Post Office. Registered for transmission by Canadian Magazine Post.

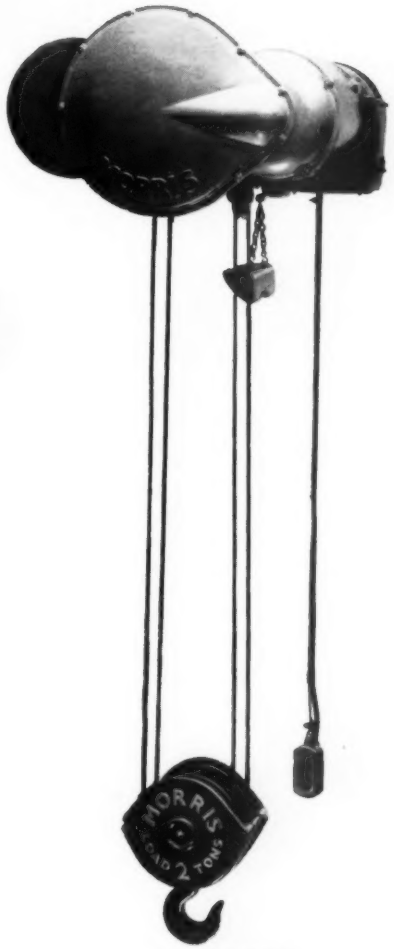
MORRIS

FOR LIFTING & MOVING

MECHANICAL HANDLING
EXHIBITION STAND NOS.
H 12 and J 14

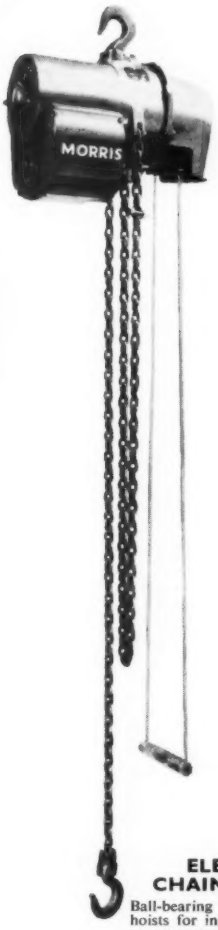
Each of these Morris products is intended to meet a definite need:—

Powerful **Lever Pull-Hoists** for pulling and lifting. **Lightweight Pulley-Blocks** for maintenance work. **Triple-Gear Pulley-Blocks** for heavy duty or process work. **Electric Chain Hoists** for general purpose lifting of light loads. **Electric Hoist-Blocks** for lifting heavier loads at higher speeds



ELECTRIC HOIST-BLOCKS

Ball-bearing electric hoist-blocks lifting on wire rope and for handling heavier loads at higher speeds. Suspension or travelling types (push or geared); also dual speed and electric travelling types. Sizes ½ to 10-tons.

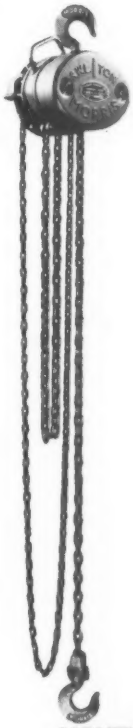


ELECTRIC CHAIN HOISTS

Ball-bearing electric chain hoists for inexpensive general purpose power lifting. Flexible chain has safety factor of 9 to 1. Pendant or push button control, suspension, travelling (push or geared) and dual speed types. Sizes ¼, ½ and 1-ton.

TRIPLE-GEAR PULLEY-BLOCKS

Highly efficient ball-bearing triple-gear pulley-blocks for heavy duty and frequent process or line production lifting. Sizes ¼ to 20-tons. Close lift built-in travelling types up to 5-tons.

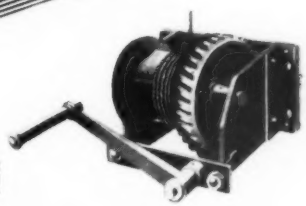


LIGHTWEIGHT PULLEY-BLOCKS

Extra lightweight triple-gear pulley-blocks with handle for carrying. Ideal for maintenance work where portability is essential. Sizes ¼, ½, 1, 1½, 2, 3 and 5-tons.

LEVER PULL HOISTS

Powerful, portable patent lever pull-hoists with flexible chain for either pulling or lifting. Factor of safety not less than 6. Sizes ¾, 1½ and 3-tons.



WALL HOISTS

Self-sustaining, machine-cut worm-gear wire rope wall hoists ¼ to 2-tons. Spur-gear for chain ⅛ to 2-tons.

HERBERT MORRIS LTD P.O. Box 7 LOUGHBOROUGH ENGLAND.

TELEPHONE: LOUGHBOROUGH 3123

XUM

Drayton service is designed to handle any problem of steam usage. Administered by competent technicians with considerable practical experience, it includes pre-sales consultation, planning and after-sales service as well as the supply and commissioning of apparatus.

Drayton

SERVICE to STEAM USERS

DRAYTON/ARMSTRONG STEAM TRAPS

Drayton manufactures also include self-operated, electrical and pneumatic controllers and indicators, as well as complete process instrumentation. Among the air-operated controllers, is the 'Dialset' indicating controller for temperature, pressure or draught, level and humidity which can be supplied with recording and/or time cycling facilities if required.

THE 'DIALSET' INDICATING CONTROLLER

The outstanding attribute of the Drayton/Armstrong steam trap is its long and useful life – normally of the order of 10 years, although many have given a much longer trouble-free service. This is the direct result of simple design, robust construction and the special manufacturing procedure whereby the valves and seats are precision lapped and mated to operate with a definite snap action and guaranteed dead tight closure. Apply for a free and unbiased trapping survey of your plant.

For descriptive literature, write to Dept. M.W.

DS 5

DRAYTON REGULATOR & INSTRUMENT CO. LTD., WEST DRAYTON, MIDDLESEX. *West Drayton 4012*